

TECHNICAL NOTE

TN-SM-83-13

TEST REPORT
FOR
MSFC TEST NO. 83- 3

WATER IMPACT TEST OF AFT SKIRT
END RING, AND MID RING SEGMENTS OF
THE SPACE SHUTTLE SOLID ROCKET BOOSTER



(NASA-CR-171027) WATER IMPACT TEST OF AFT
SKIRT END RING, AND MID RING SEGMENTS OF THE
SPACE SHUTTLE SOLID ROCKET BOOSTER (Chrysler
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TECHNOLOGY

HUNTSVILLE ELECTRONICS DIVISION



CHRYSLER
CORPORATION

MICHOUD ENGINEERING OFFICE

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CONTRACT NAS8-35017

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THE SPACE SHUTTLE SOLID ROCKET BOOSTER

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FOREWORD

This report represents results of water impact loads tests using Aft Skirt End Ring, and Mid Ring Segments of the Space Shuttle Solid Rocket Booster (SRB).

The tests were conducted in May/June 1983 by Chrysler Corporation, for NASA/MSFC at the Hydroballistics Facility of the Naval Surface Weapons Center, White Oak, Maryland.

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PRESSURE, FORCE, AND ACCELERATION
DATA TIME HISTORY PLOTS

VOL.

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- 2 AFT RING MODEL RUNS 23 THROUGH 45
- 3 MID RING MODEL RUNS 10 THROUGH 24
- 4 MID RING MODEL RUNS 27 THROUGH 46

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SECTION I - INTRODUCTION

Water impact loads tests using two aft skirt ring segment models of the Space Shuttle Solid Rocket Booster configuration were conducted May/June 1983 at the Naval Surface Weapons Center, White Oak, Maryland.

The primary objectives of this water impact test program were:

- a. Obtain water impact applied pressure and associated dynamic structural response strain data for structures which simulates a partial segment of the SRB aft skirt, mid and aft rings.
- b. Evaluate effects of foam and foam contour shape (including STS-7 contours) on applied pressures and associated structural dynamic responses.
- c. Evaluate effects of removing selected structural reinforcements such as clips and gussets.
- d. Assess a proposed mid ring alternative design for water impact structural dynamic responses.
- e. Obtain water impact data for full-scale baseline impact velocities and for the reduced impact velocities associated with the larger main chute system.
- f. During the final phase of the test program, increase the impact velocity until the aft ring segment fails in the no foam configuration. (Aft Ring Segment only).

A total of 46 tail first shots were made during this test. Model entry conditions were full scale vertical velocities of approximately 22 to 113 ft/sec, and impact angles of 0 to plus or minus 10 degrees. All tests were conducted at atmospheric pressures 14.7 psia or 760 mm.Hg.

This report contains a description of the models, test program, test facility, test equipment, instrumentation systems, data reduction procedures, and test results.

SECTION II - MODEL DESCRIPTION

The first model used for the test program was an aft skirt end ring segment (approx. 30 degree segment) simulation of the STS-5 configuration. It consists of 52" wide, 38" long, and 0.5" thick flat skin panel with (6) stringers, (after machining) skirt aft ring, gussets, closeout plates, and adapter base as illustrated in Figures 1 thru 5. This model configuration was varied as noted in this text. The baseline mass characteristics were;

Weight - 435 lbs.

Moment of Inertia - 58.68 Slug Sq.Ft.

C.G. Location - 26.5 in. from aft ring

The second model consisted of two SRB Aft Skirt Mid Ring Segments (approx. 15 degree segments, without curvature) in a wedge shape structure, 42"x28" wide, 69" long and 0.5" thick skin panels. Located approximately half way up on one side of the wedge is a full-scale aft skirt mid ring segment configured with structural reinforcement similar to the current baseline SRB design. The other side of the wedge contains an alternative candidate design for the mid ring. The skin panels are flight design configured to include the integrally milled stiffeners above and below the mid ring, Figures 6 thru 10. The baseline weight of the model segment was 655 lbs.

Both models were fabricated from 2919-T87 aluminum and each model was attached to a barrel rod with adapter plates, Figures 11 thru 13. Model

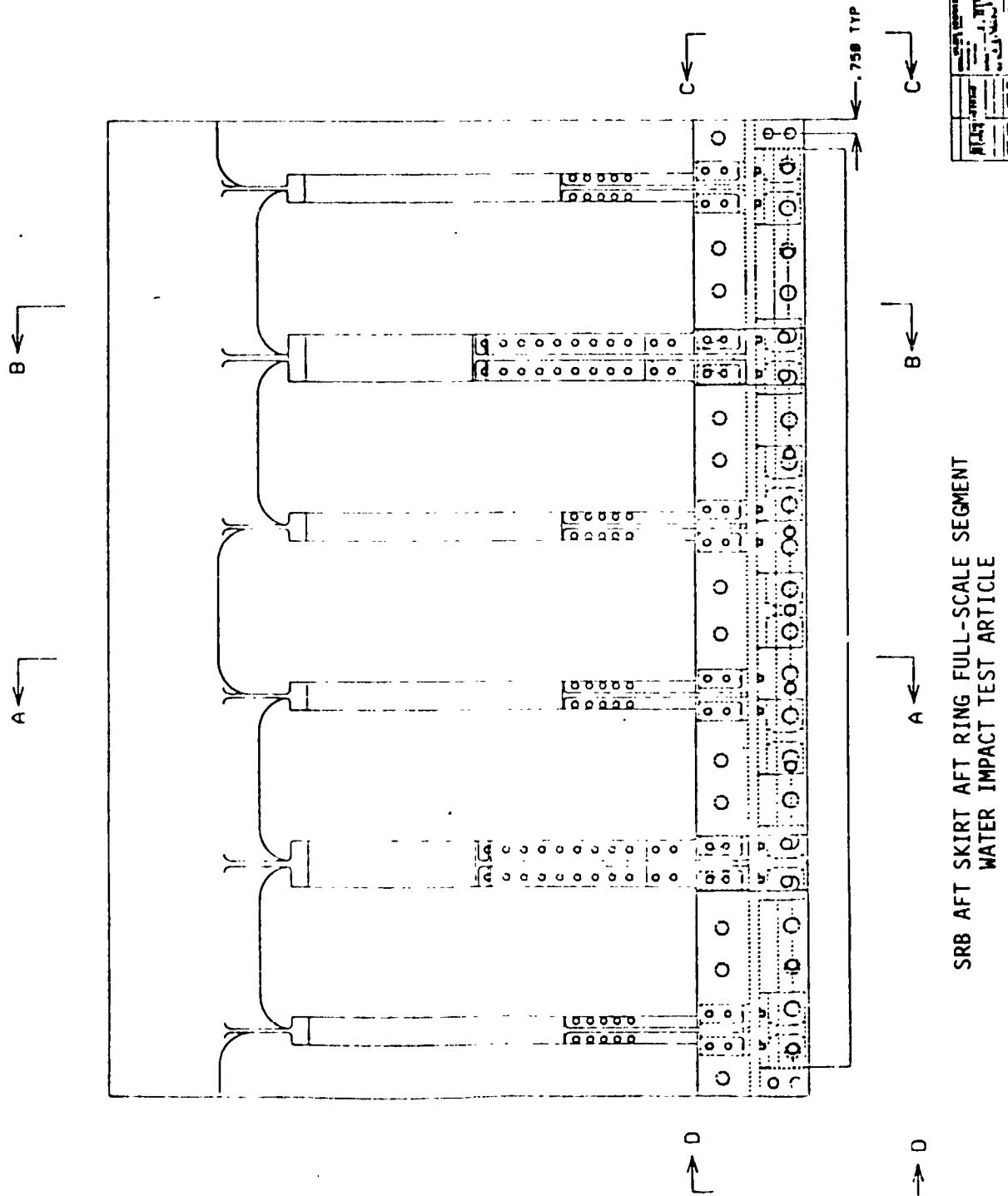
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weight measurements were made without the instrument cables attached to the model. The instrument cables were supported and dropped independent of the model in each of the tests, therefore the acceleration weight of the instrument cables was considered negligible, Figure 14.

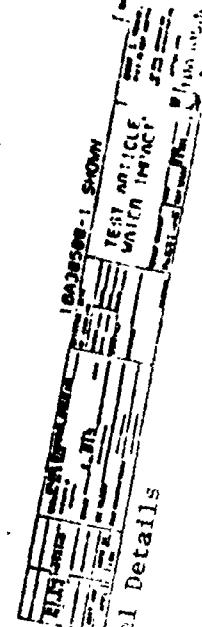
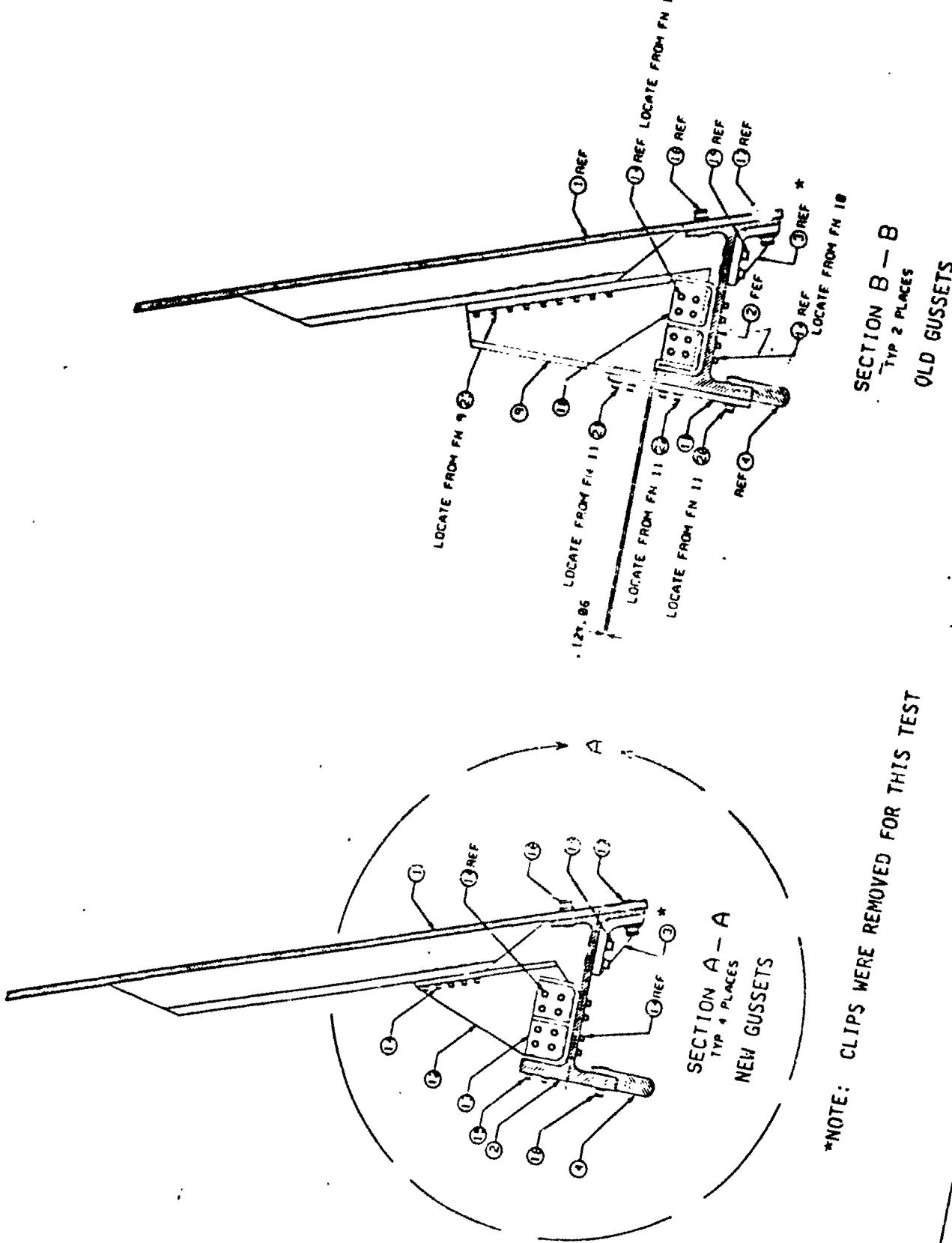
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NOTES:

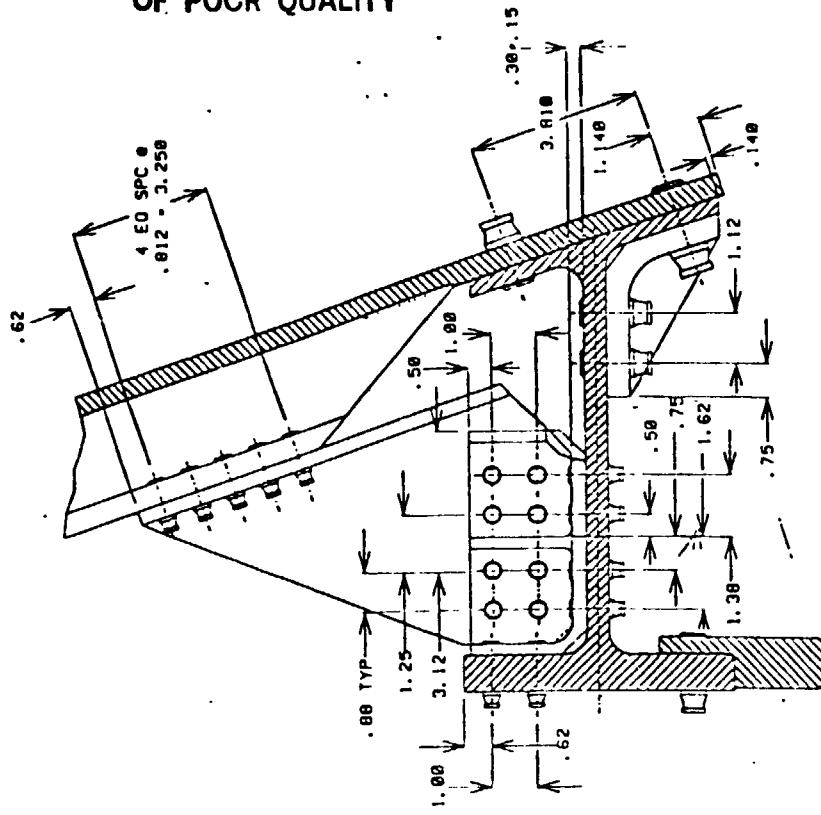
- 1 REMOVE BURRS & DEBRIE DURING FAB
- 2 TORQUE FASTENERS PER
- 3 HSSC-370-406
- 4 SEAL ALL FASTENED SURFACES PER
- 5 ISMBP26, P/N 1.0
- 6 FOR 1/4 DIA FASTENERS, DRILL
- 7 2300, 2500 DIA HOLE
- 8 FOR SPRG DIA FASTENERS, DRILL
- 9 .3125-.316 DIA HOLE
- 10 FOR 3/8 DIA FASTENERS, DRILL
- 11 .315-.317 DIA HOLE
- 12 FOR 1/2 DIA FASTENERS, DRILL
- 13 3400, 3600 DIA HOLE
- 14 WHEN BOLT LENGTH SPECIFIED DO NOT ALLOW PROPER PROTRUSION
- 15 THRU HLT. SUBSTITUTE THE NEXT LONGER OR SHORTER HLT OR 1/4 INCH THICKER IN THICKER OR THINNER WASHER ON BOTH



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**NOTE: CLIPS WERE REMOVED
FOR THIS TEST**

**DETAIL A
SCALE 1/1**

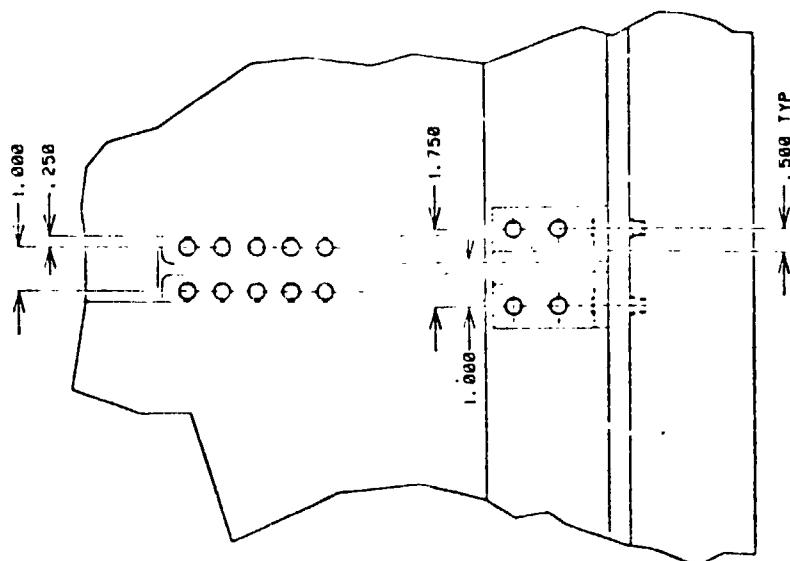
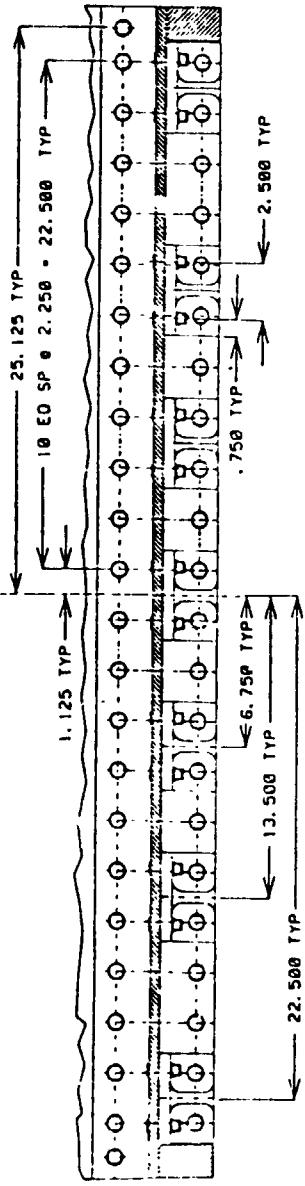
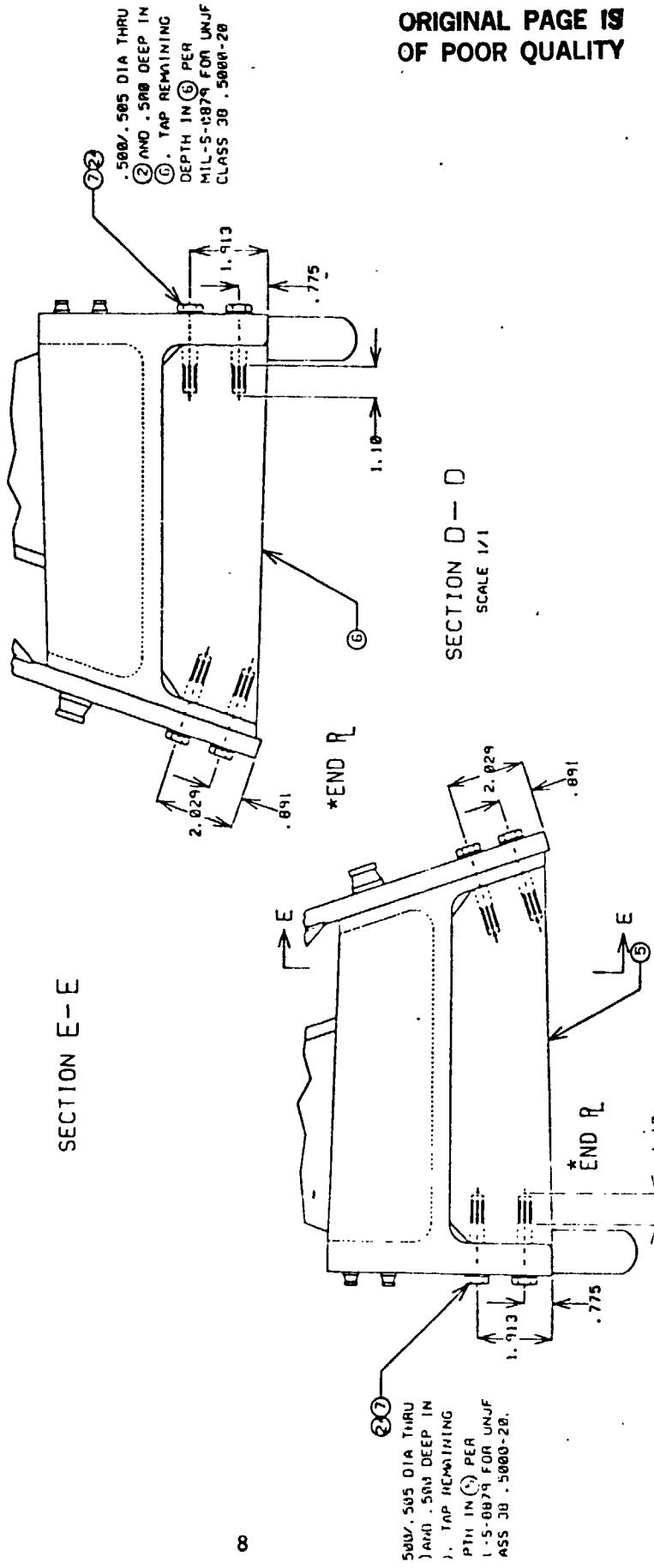


Figure 3 = Aft Ring Segment Model Details



SECTION E—E



*NOTE: END PLATES WERE NOT USED IN THIS TEST

100A30500-1	SHOWN
TEST ARTICLE	WORN INVESTIGATION
TEST NUMBER	TEST DATE
TESTER	TESTER SIGNATURE
TEST LOCATION	TEST LOCATION SIGNATURE

Figure 4 - Aft Ring Segment Model Details

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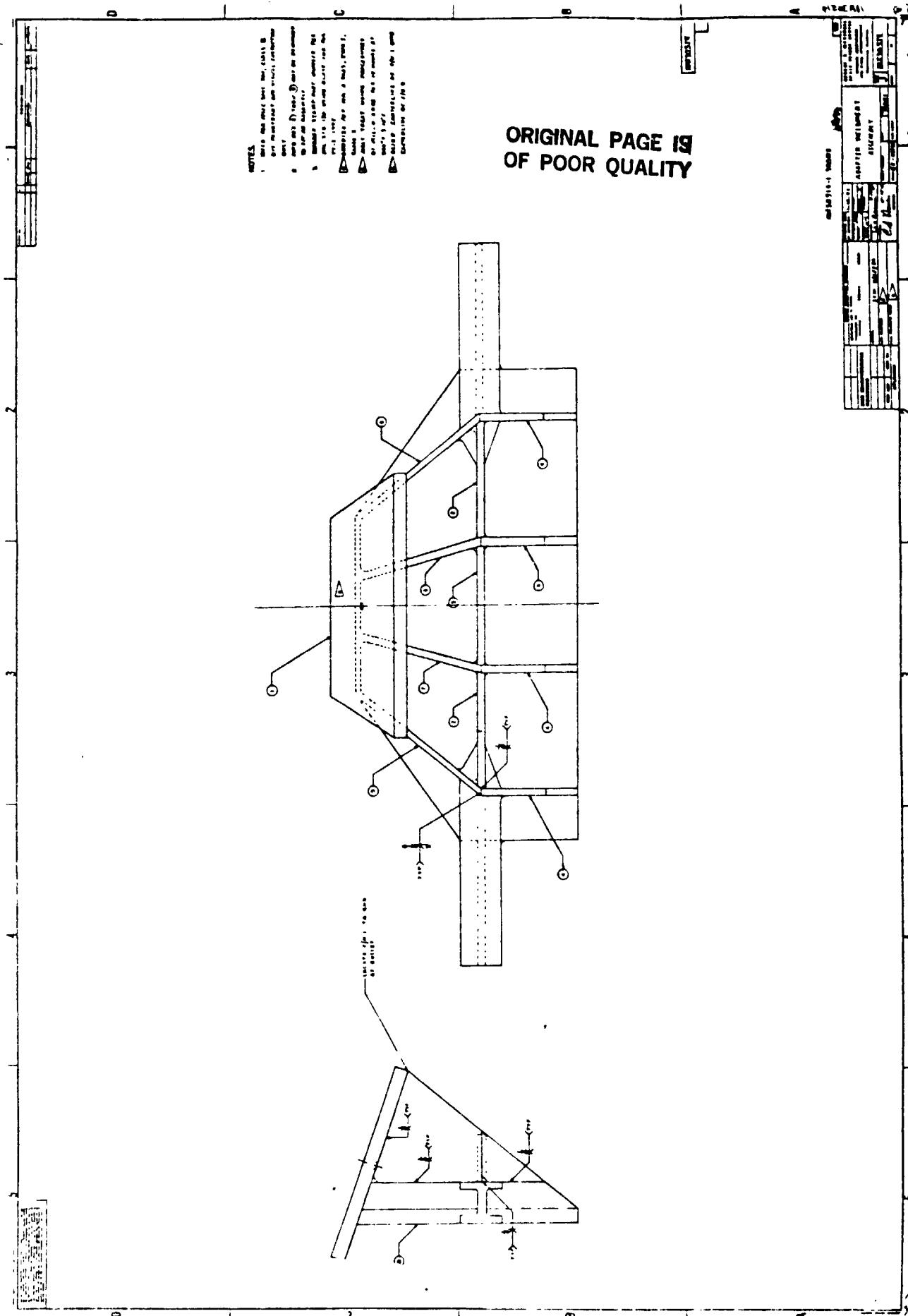


FIGURE 5 - Aft Ring Segment Model Details

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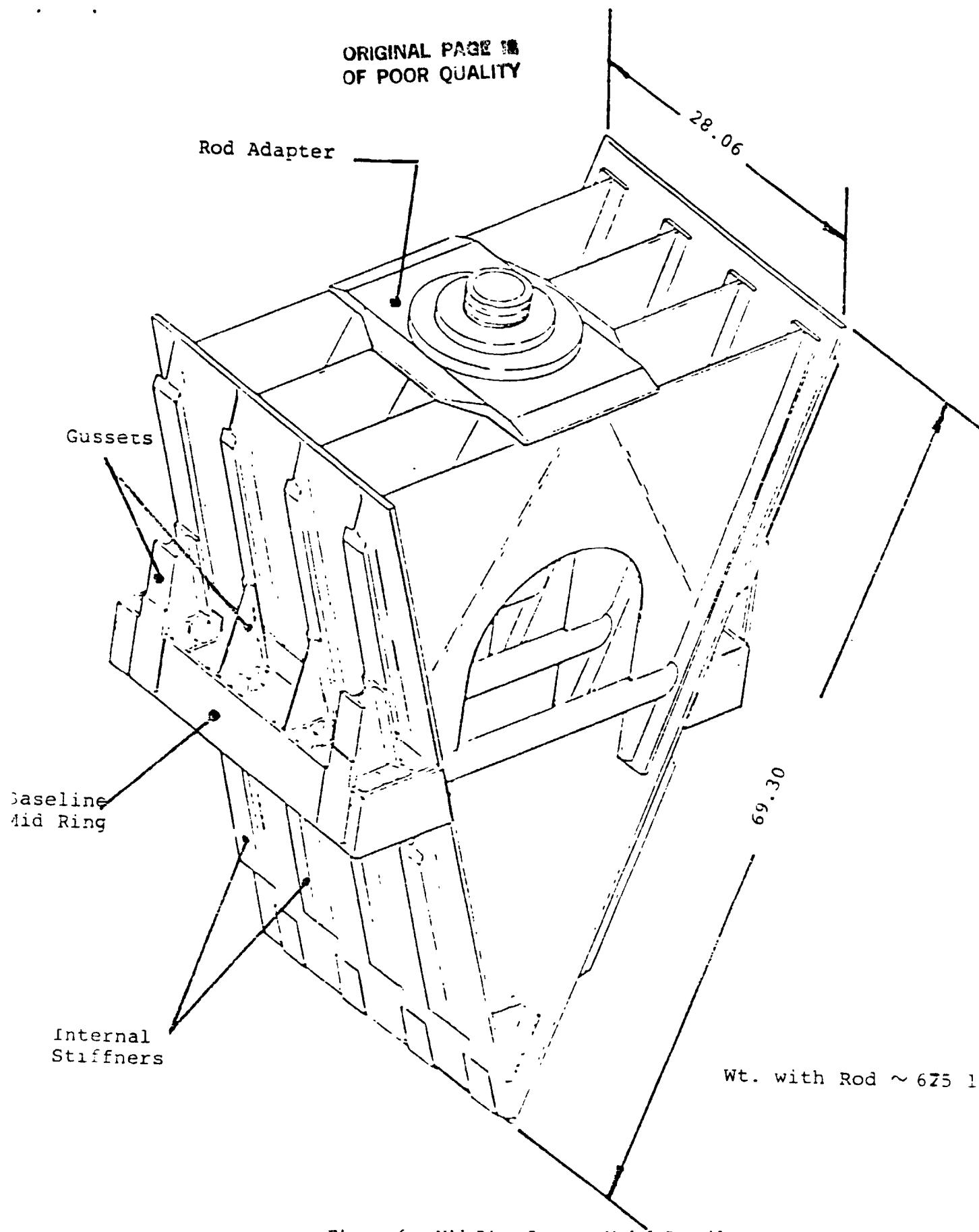


Figure 6 - Mid Ring Segment Model Details

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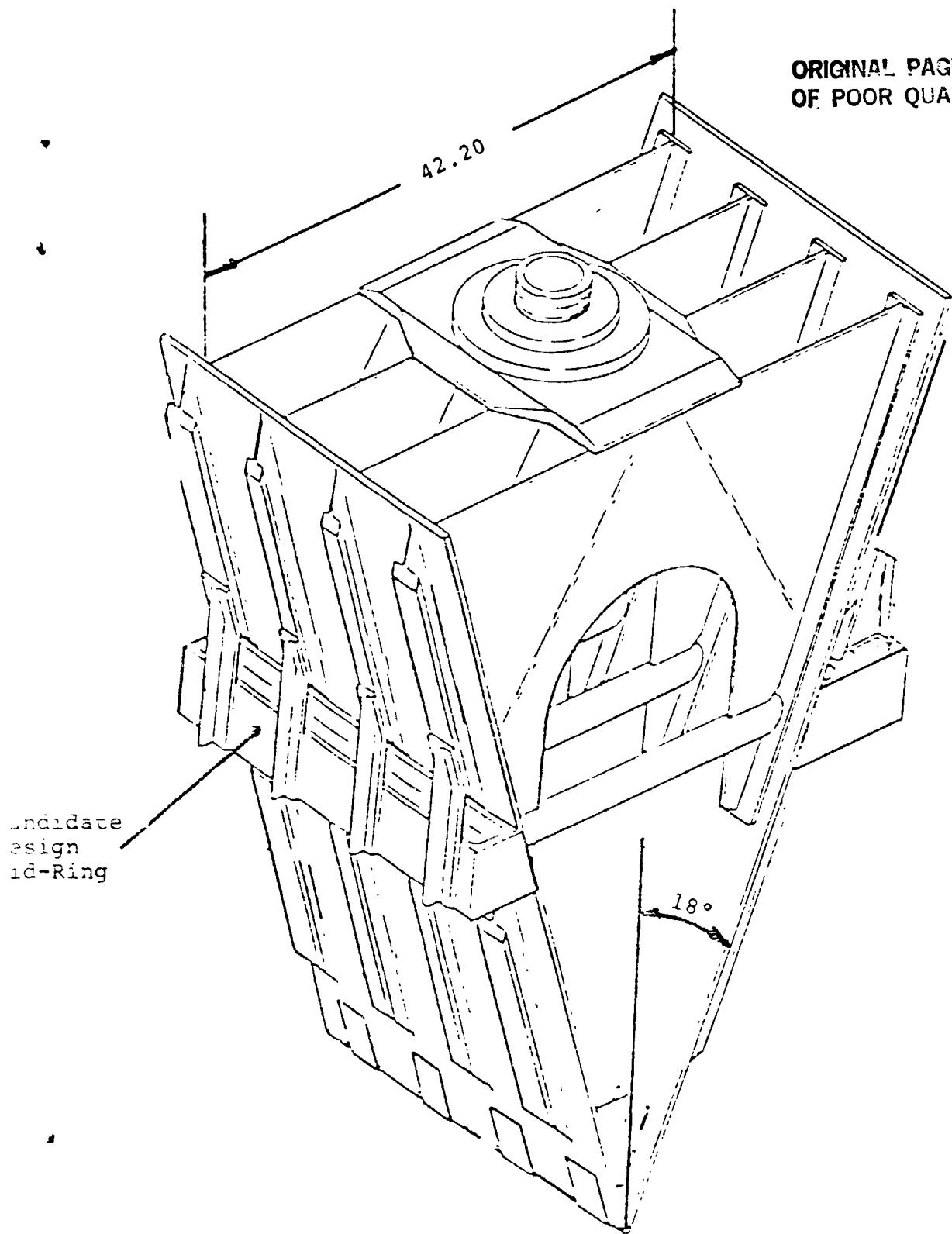


Figure 7 - Mid Ring Segment Model Details

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NOTES:

1. REMOVE BURRS FROM SIGHT HOLES
2. USE AN INCH TUBE SHEAR TO CUT OUT 1/2 INCH LENGTH OF TUBE, WITHIN 1/4 INCH FROM END, AND CUT ON ONLY ONE SIDE.
3. RELOCATE SIGHT HOLES, EXCEPT AS INDICATED ON DRAWING.
4. SUBSTITUTION OF WELD CHAMBERS FOR TUBE HOLES IS PERMITTED.
5. USE OF PLAIN PIPE FOR HOLE IS NOT PERMITTED.
6. THROUGH FAIRINGS ARE INSPECTED FOR ALL WELDS TO BE CONTINUOUS AND FREE FROM DOUBLE SPLASH WELDS, EXCEPT AS SHOWN ON DRAWING. THE FAIRING IS TO BE CUT OFF AS NECESSARY TO CLEAR THE FAIRING AS LOW AS POSSIBLE. (C) INDICATES WHERE FAIRING IS TO BE CUT OFF.
7. DRILL HOLE DIA. 1/2 INCH, DEPTH 1/2 INCH, TAPER 1/4 INCH PER CC. A-124/10
8. DRILLED BY TAKI TAK, INC.
FOR 250 DRILL TEMPLATES INC DIA. HOLE
FOR 512 DRILL TEMPLATES 3/16 DIA. HOLE
250
FOR 116 DRILL TEMPLATES .075 DIA. HOLE
.075
PLATE MAY OR SHOULD BE SPOT-FACED AS NECESSARY TO CLEAR HEAD AND/OR NUTS AND TO ALIGN DRILLED HOLE LOCATED FROM PILOT HOLES
DRILL HOLES FROM DRILL TEMPLATE ALUM ALLOY 6061-T6 PER QQ-A-2500

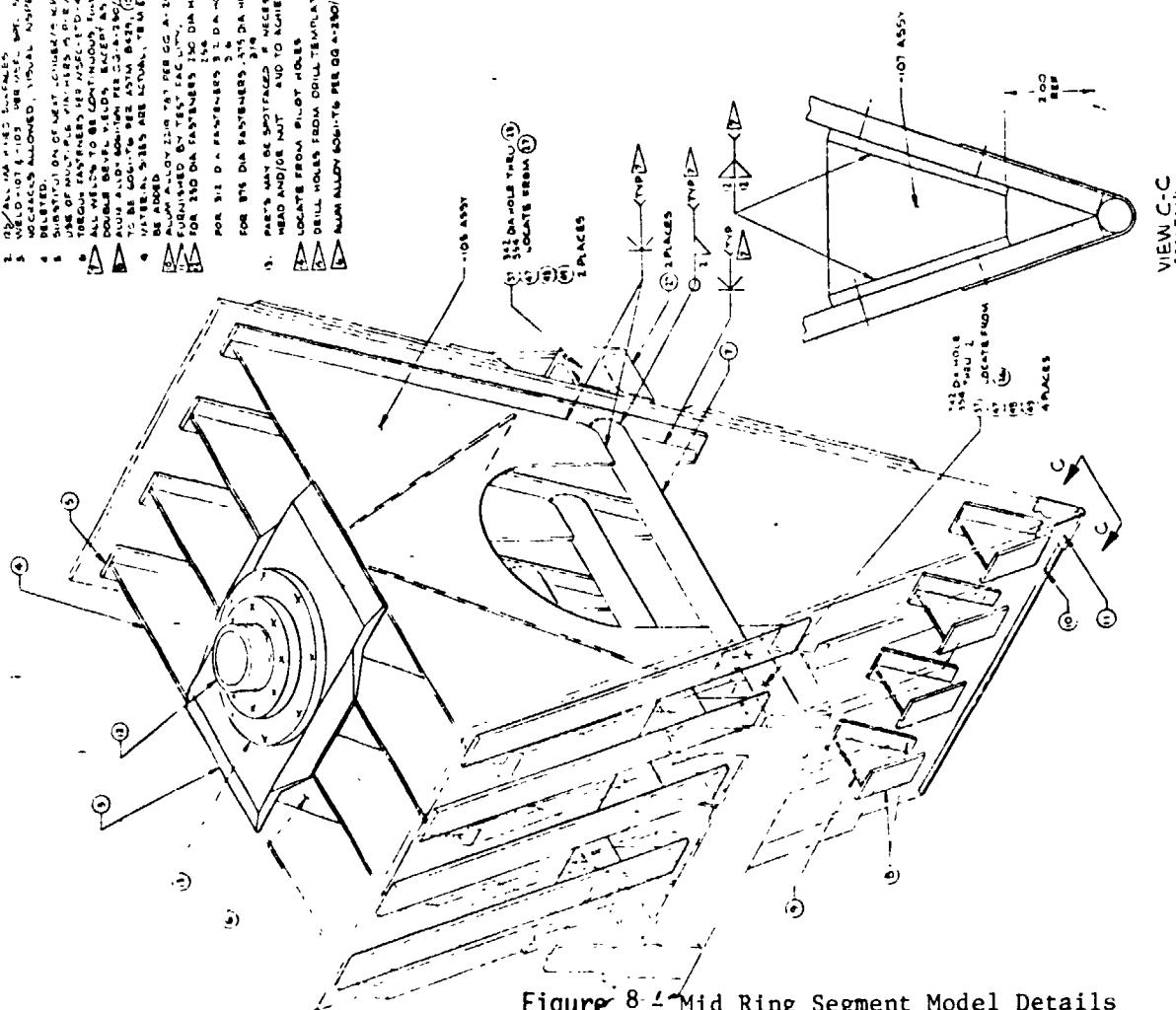
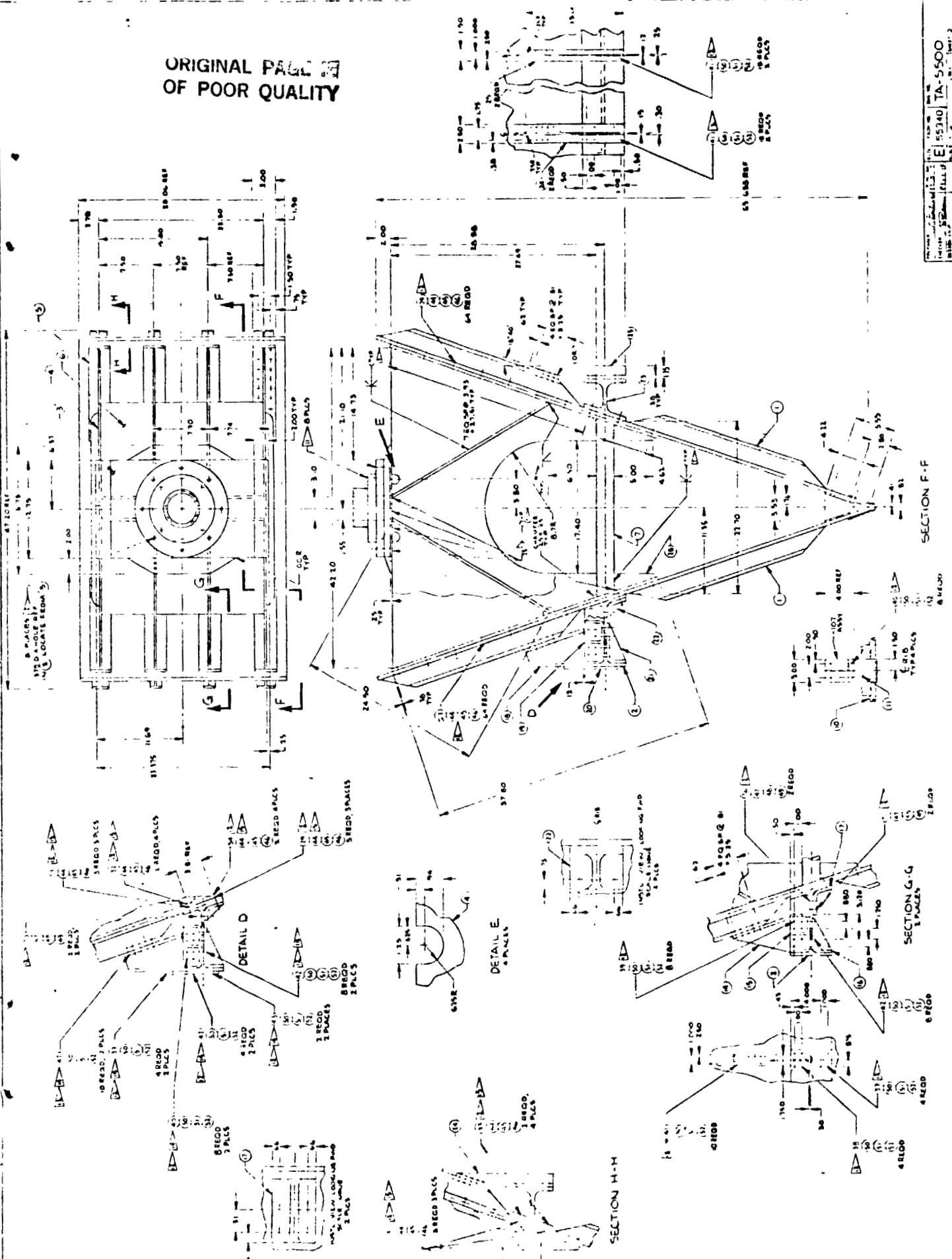


Figure 8 - Mid Ring Segment Model Details

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Mid Ring Segment Model Details
Figure 9

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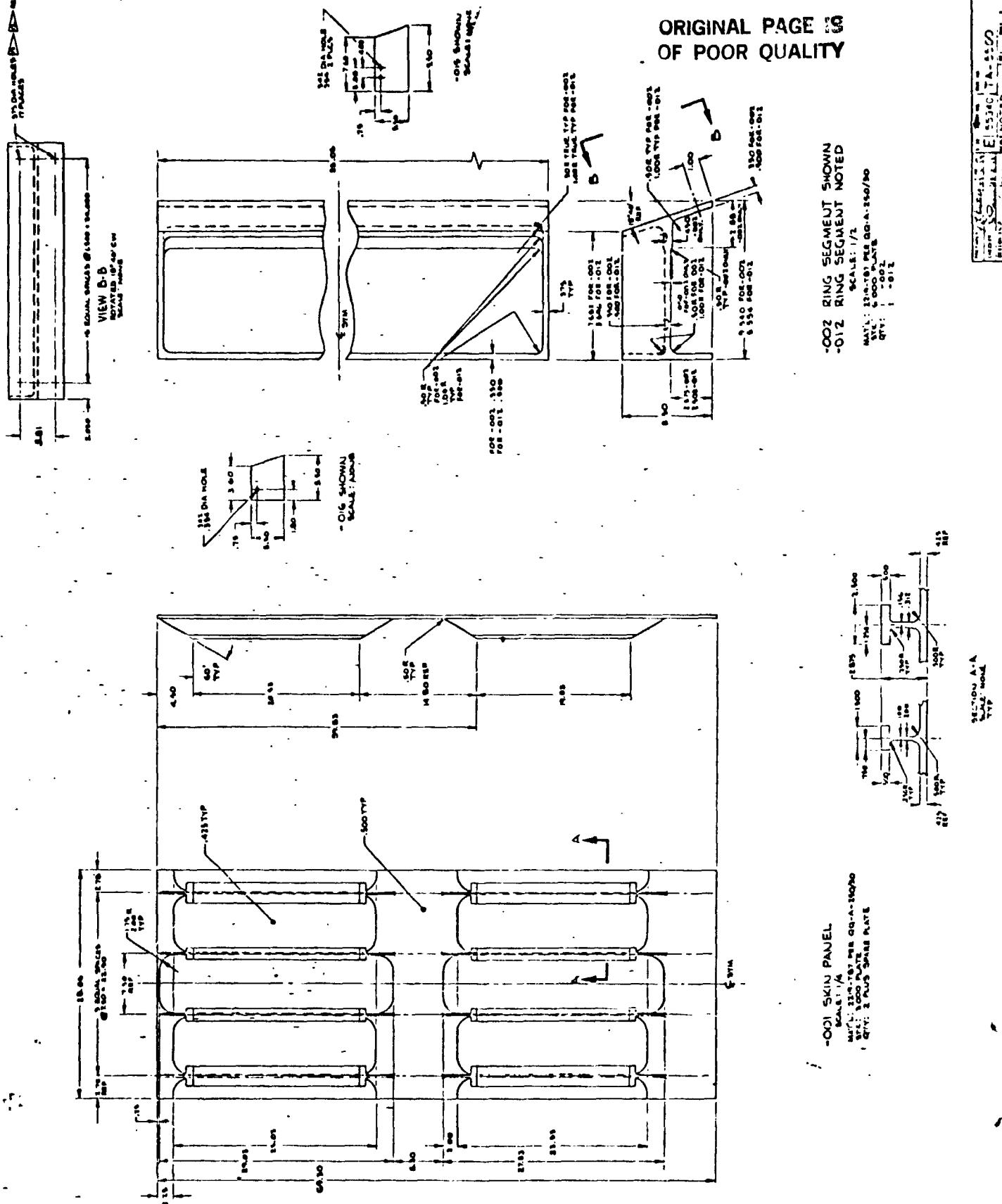


Figure 10 - Mid Ring Segment Model Details

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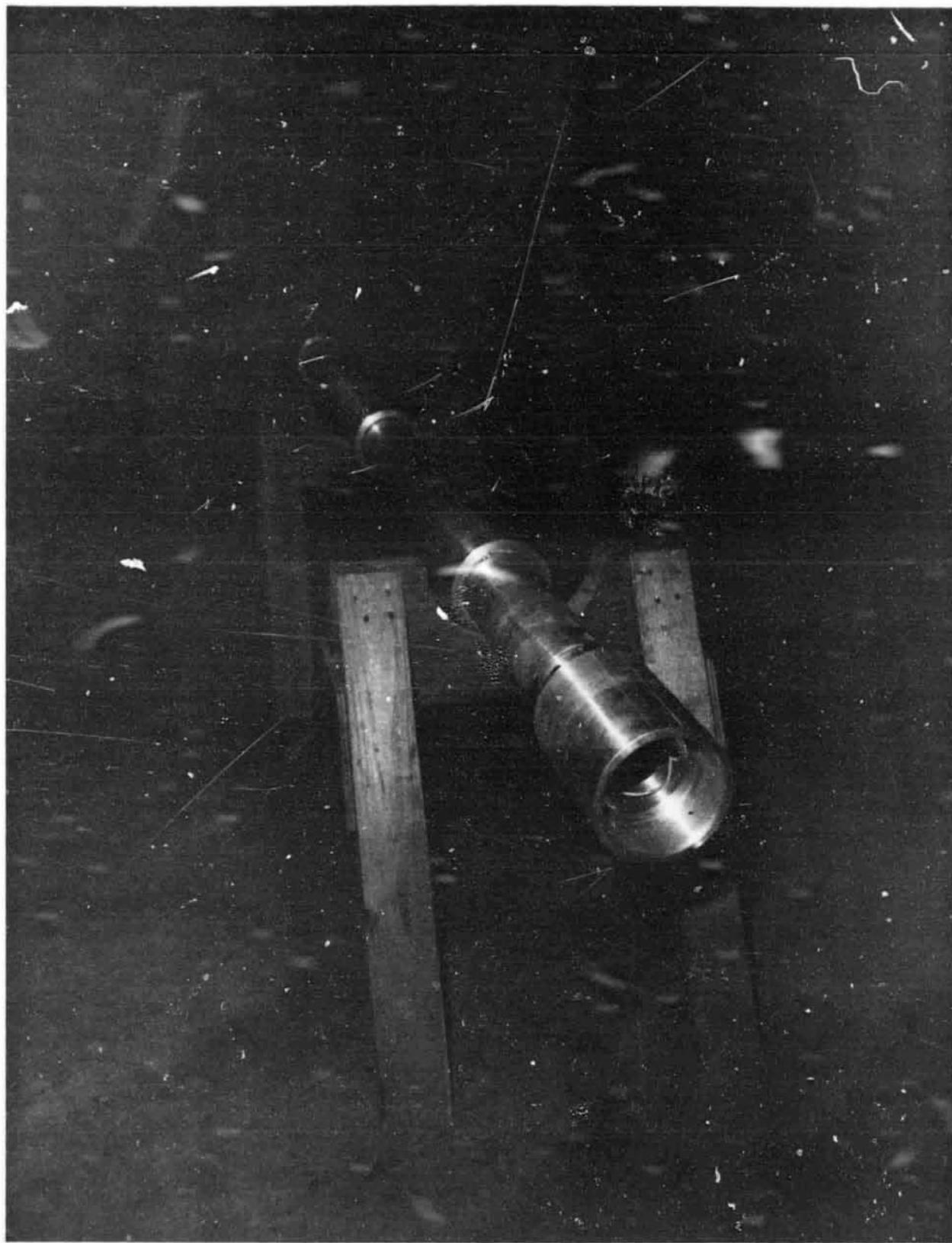


Figure 11 Barrel Rod (Photo)

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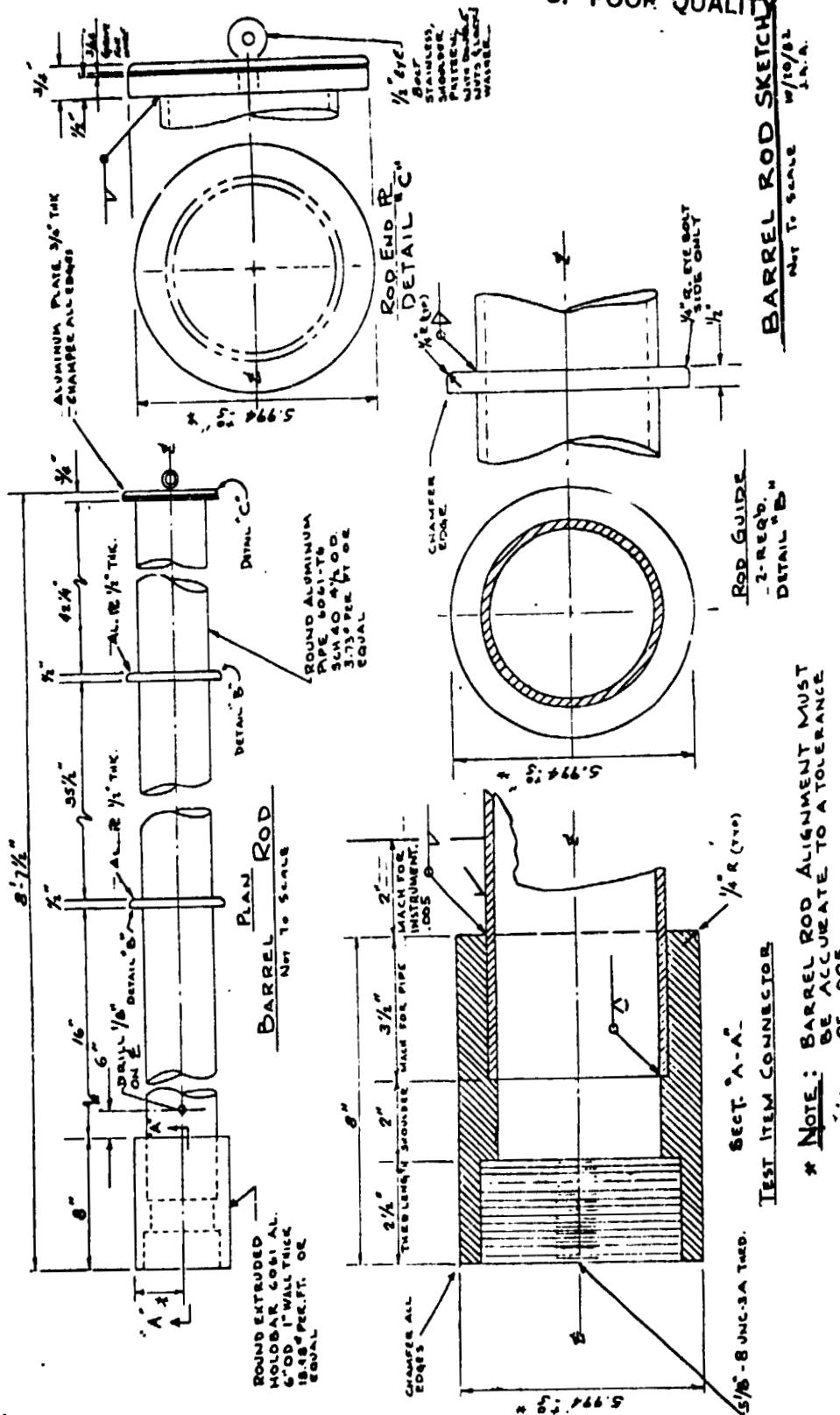
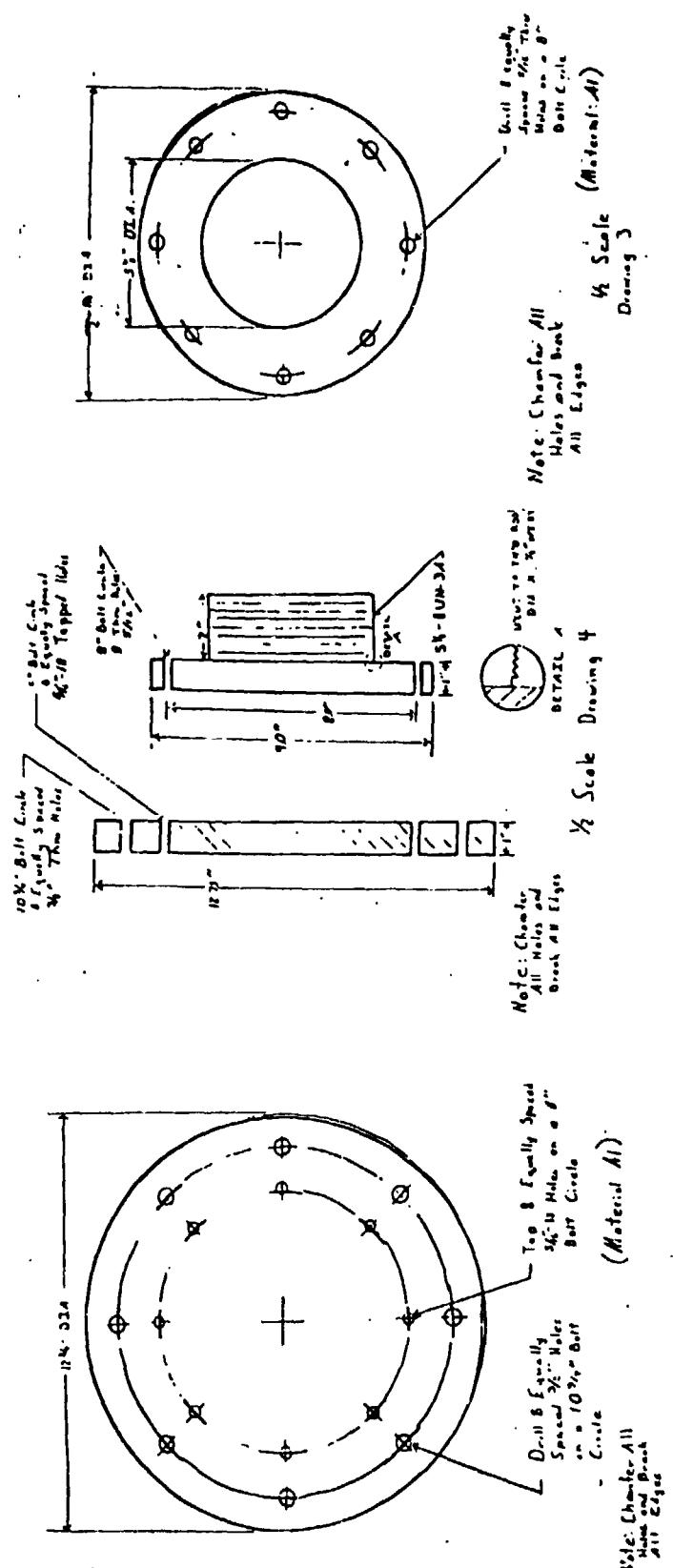


FIGURE 12- BARREL ROD DETAILS



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Figure 13- Barrel Rod Adapter Plate

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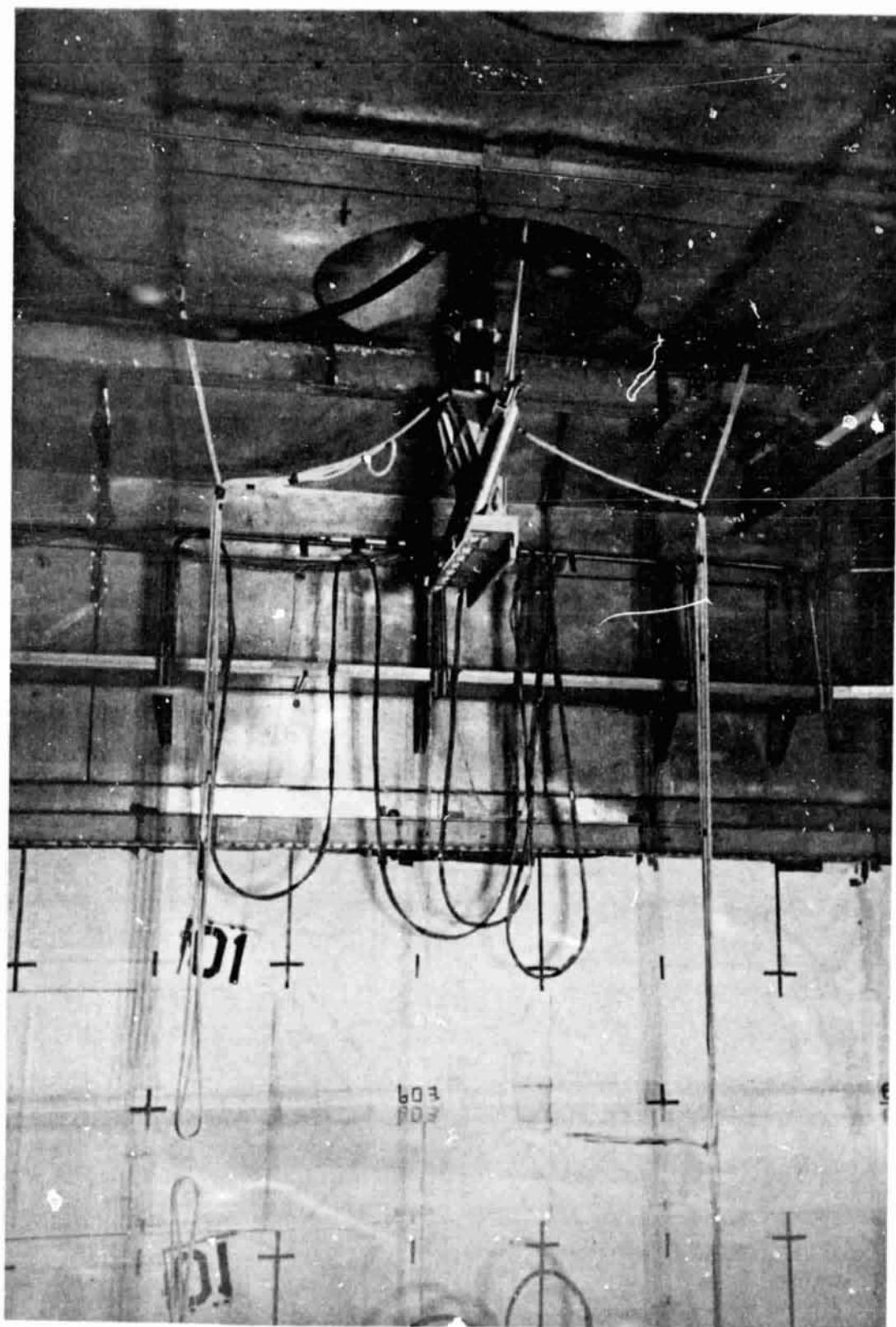


Figure 14 - Model Loaded in Air Gun

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SECTION III - ELECTRICAL INSTRUMENTATION

The Aft Ring Segment model was instrumented with 3 crystal type accelerometers, 12 piezoelectric pressure transducers, 27 uniaxial, (3 located on rod) and 31 rosette foil strain gages. The instruments along with their location and function are listed in Table I and illustrated in Figures 15 thru 52. Not all of the instruments could be recorded during each test run.

Figure 53 shows model accelerometer locations. These consisted of axial, pitch, and yaw accelerometers. The accelerometers were located above the CG of the model. Accelerometer sign convention is as illustrated by Figure 53.

The Mid Ring Segment model was instrumented with 3 crystal type accelerometers, 12 piezoelectric pressure transducers, 57 uniaxial, (3 located on rod) and 28 rosette foil strain gages. The instruments along with their location and function are listed in Table II and illustrated in Figures 54 through 104. Not all of the instruments could be recorded during each test run.

All instruments were water proofed with a combination of scotch cast epoxy resin, RTV, silicone grease, and caterpillar cement. To protect the pressure

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transducers from thermal shocks, the diaphragms were recessed approximately 1/16 of an inch below the model skin and covered with RTV. To protect the transducers' connectors at water impact, small metal blocks and brackets were added to the model, Figure 25. All instruments were bench calibrated prior to installation in the model and were check calibrated through the model instrument system after all wiring had been completed.

Instrument signals were transmitted from the model through four instrument cables attached to the model adapter base. The cables were approximately 3/4 inches in diameter, 130 feet long. They were made up of 50 shielded pairs of 24 gage teflon insulated wire. All instruments used a 5 volt common power which was connected to the individual instruments throughout the model.

Pressure, acceleration and strain gage outputs from the instrument cable were fed through appropriate couplers or signal conditioners/amplifiers to five 28 channel FM tape recorders. Data was recorded at 30 IPS, wide band, (108 KHZ center frequency). IR16"B" time was recorded on each recorder. Only 130 channels of data plus time code on every fourteen channel was recorded. Figures 105 and 106 show the data recording system set-up.

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Inst. I. U.	Type Meas.	Location	Remarks*
A1	PCB Piezotronics High Freq. Model	Between Stiffner 1 & 2 Outer Flg.	All Runs
A2	H113A22 Pressure Transducer	Web Center	
A3		Inner Flg.	Not Recorded Run 45
A4		Whalebone	
A5		Near Stiffner 4 Outer Flg.	All Runs
A6		Web Center	
A7		Inner Flg.	Not Recorded Run 45
A8		Whalebone	
A9		Between Stiffner 5 & 6 Outer Flg.	All Runs
A10		Web Center	
A11		Inner Flg.	Not Recorded Run 45
A12		Whalebone	
EAI	PCB Model H3U2 A04 Quartz Accelerometer	Axial at Rod/Model Interface Plate	All Runs
EP2		Pitch	
EY3		Yaw	All Runs
SA1	BLH Uniaxial Constant Foil Strain Gage	Barrel Rod Adapter Axial	Not recorded Runs 20 thru 23, 25, 26, 31, 32, 34, 36, 39, and 41 thru 45
SP1		Barrel Rod Adapter Pitch	
SY3		Barrel Rod Adapter Yaw	

TABLE I - INSTRUMENTATION - AFT RING SEGMENT

Inst. I. D.	Type Meas.	Location	Remarks*
U1	BLH Uniaxial Constantan	Old Gusset - Stiffner #2	All Runs
U2	Foil Strain Gage	#2	Not Recorded on Run 15
U3		#5	All Runs
U4		#5	
U5		New Gusset - Stiffner #1	
U6		#1	All Runs
U7		#3	Not Recorded Runs 22, 23, 25, 26, 31, 34 & 36
U8		#3	Not Recorded on Runs 15, 22, 23, 25, 26, 31, 34 & 36
U9		#4	Not Recorded Runs 22, 23, 25, 26, 31, 32, 34, 36
U10		#4	All Runs
U11		#6	
U12		#6	
U13		Skin - Stiffner #1	ORIGINAL PAGE OF POOR QUALITY
U14		#2	
U15		#3	
U16		#4	
U17		#5	All Runs
U18		#6	

TABLE : - INSTRUMENTATION - AFT RING SEGMENT
(Continued)

Inst. No.	Type Meas.	Location	Remarks*
U19	BLH Uniaxial	Near Stiffner Bottom Outer Ring Flg. (See Note #1)	All Runs
U20	Constantan Foil	Near Stiffner 2-3 Bottom Outer Ring Flg. (See Note #1)	All Runs
U21	Strain Gage	Near Stiffner 2-3 Bottom Outer Ring Flg. (See Note #1)	Not Recorded Run 20
U23		Near Stiffner 5 Bottom Outer Rin ⁵ Flg. (See Note #1)	All Runs
U24		Near Stiffner 4-5 Bottom Outer Ring Flg. (See Note #1)	
U25		Near Stiffner 6 Bottom Outer Ring Flg. (See Note #1)	All Runs
U26		Adapter Plate	Not Recorded Runs 20 thru 23, 25, 26, 31, 32, 34, 36, 39, 41 thru
U27		Adapter Plate	

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NOTE #1 - NEW UNIAXIAL STRAIN GAGE INSTALLED ON OUTER FLANGE IN AREA VACATED BY REMOVING CLIP -
SAME INSTRUMENT IDENT NUMBER REUSED.

#2 - U22 NOT RECORDED THIS TEST.

TABLE I - INSTRUMENTATION - AFT RING SEGMENT
 (Continued)

Inst. I. D.	Type Meas.	Location	Remarks*
R1-1	BLH Rosette Constantan Foil Strain Gage	Inner Flange - Stiffner 3	All Runs
2			
3			
R2-1			
2			
3			
R3-1			
2			
3			
R4-1		Outer Elange - Stiffner 1-2	All Runs
2			
3			
R5-1			
2			
3			
R6-1			All Runs
2			
3			

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TABLE I - INSTRUMENTATION - AFT RING SEGMENT
(Continued)

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Inst. I. O.	Type Meas.	Location	Remarks*		
			All Runs		
R7-1	BLH Rosette	Outer Flange Stiffner 4			
2	Constantan Foil	4			
3	Strain Gage	4			
R8-1		4-5			
2		4-5			
3		4-5			
R9-1		5-6			
2		5-6			
3		5-6			
R10-1	Old Gusset - Stiffner 2		All Runs		
2		2	Not Recorded		
3		2	Runs 2, 4, 7 & 9		
R11-1		5	Not Recorded		
2		5	1, 3, 5, 8, 15, 34, 36		
3		5	39, 41 thru 45		
R12-1	Outer Flange - Between Stiffner 3 & 4		All Runs		
2		1	All Runs		
3		1			

TABLE I - INSTRUMENTATION - AFT RING SEGMENT
(Continued)

Inst. I. D.	Type Meas.	Location	Remarks*
R13-1	BLH Rosette	Ring Web - Stiffner 1-2 Outer Flg Bottom	All Runs
	Constantan Foil	1-2	All Runs
	Strain Gage	1-2	All Runs
R14-1	New Gusset - Stiffner 3	3	Not Recorded Runs 15, 20 thru 23, 24, 26, 31, 32, 34 & 36
		3	Not Recorded Run 22, 23, 26, 31, 34 & 36
		3	Not Recorded Runs 15, 20 thru 23, 24, 26, 31, 32, 34 & 36
R15-i		3	Not Recorded Run 22, 23, 26, 31, 34 & 36
		3	Not Recorded Run 22, 23, 26, 31, 34 & 36
		3	Not Recorded Run 22, 23, 26, 31, 34 & 36
R16-1		3	Not Recorded Run 22, 23, 26, 31, 34 & 36
		3	Not Recorded Run 22, 23, 26, 31, 34 & 36
		3	Not Recorded Run 22, 23, 26, 31, 34 & 36
R17-1		4	Not Recorded Run 22, 23, 26, 31, 34 & 36
		4	Not Recorded Run 22, 23, 26, 31, 34 & 36
		4	Not Recorded Run 22, 23, 26, 31, 34 & 36
R18-1	Inner Flange - Stiffner 2	4	All Runs
		4	All Runs
		4	All Runs

TABLE I - INSTRUMENTATION - AFT RING SEGMENT
(Continued)

Inst. I. D.	Type Meas.	Location	Remarks*
R19-1	BLH Rosette Constantan Foil Strain Gage	Inner Flange - Stiffner 1-2 1-2 1-2	All Runs
2			All Runs
3			Not Recorded Runs 2, 4, 7, 9, 20 & 22, 25 & 31
R20-1		Stiffner 3 3 3 3	Not Recorded Runs 1 thru 5, 7 thru 9, 15, 21, 23, 26 & 32
2			
3			
R21-1		4	
2		4	
3		4	
R22-1		Ring Web - Stiffner 3-4 Inner Flg. Top	All Runs
2			
3			Center Top
R23-1			
2			
3			Outer Flg. Top
R24-1			
2			
3			All Runs

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TABLE I - INSTRUMENTATION - AFT RING SEGMENT
(Continued)

Inst. I. D.	Type Meas.	Location	Remarks*
R25-1	BLH Rosette Constantan Foil	Ring Web - Stiffner 3-4 Inner Flg Bottom	All Runs
2	Strain Gage		
3			
R26-1		Center Bottom	
2			
3			
R27-1		Outer Flg Bottom	
2			
3			
R28-1		- Stiffner 1-2 Inner Flg Bottom	
2			
3			
R29-1		Center Bottom	
2			
3			
R30-1		Center Top	
2			
3			
			All Runs

TABLE I - INSTRUMENTATION - AFT RING SEGMENT
(Continued)

Inst. I. D.	Type Meas.	Strain Gage	Location	Remarks*	
				All Runs	All Runs
R31-1			Inner Flange - Stiffner 4-5		
2					
3					

TABLE I - INSTRUMENTATION - AFT RING SEGMENT
(Concluded)

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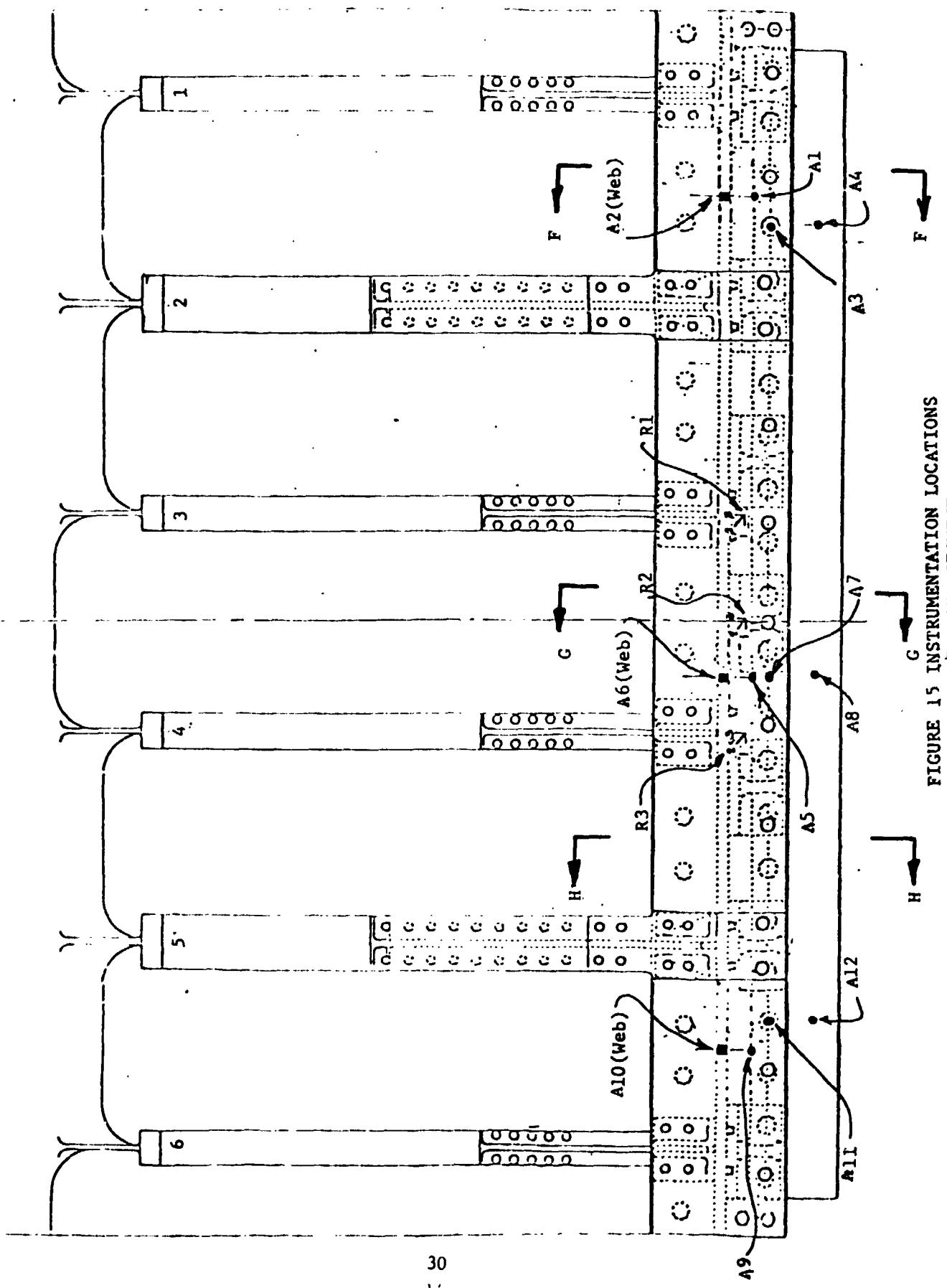
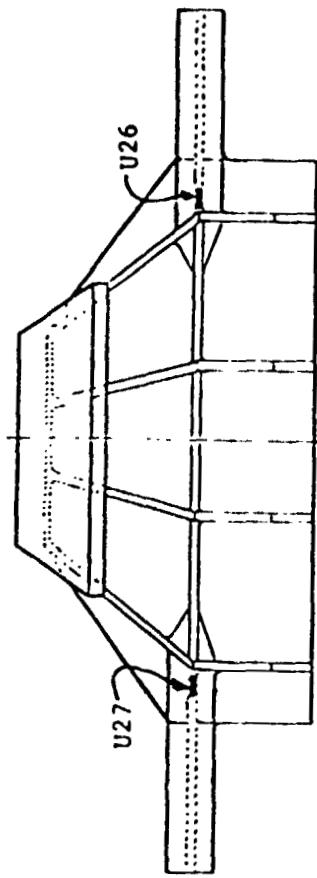
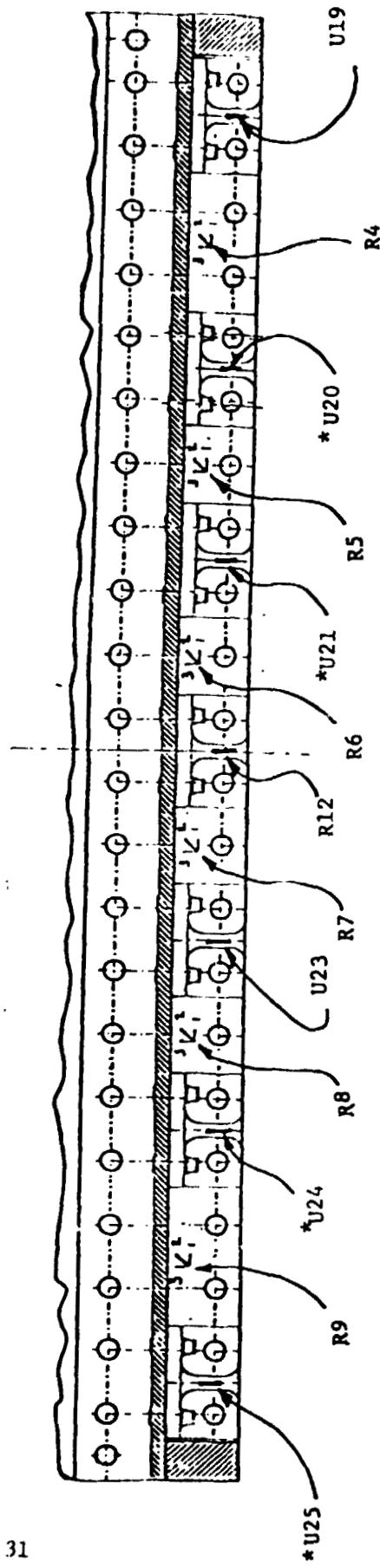


FIGURE 15 INSTRUMENTATION LOCATIONS
AFT RING SEGMENT

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Adapter



AFT RING OUTER FLANGE
SECTION EE

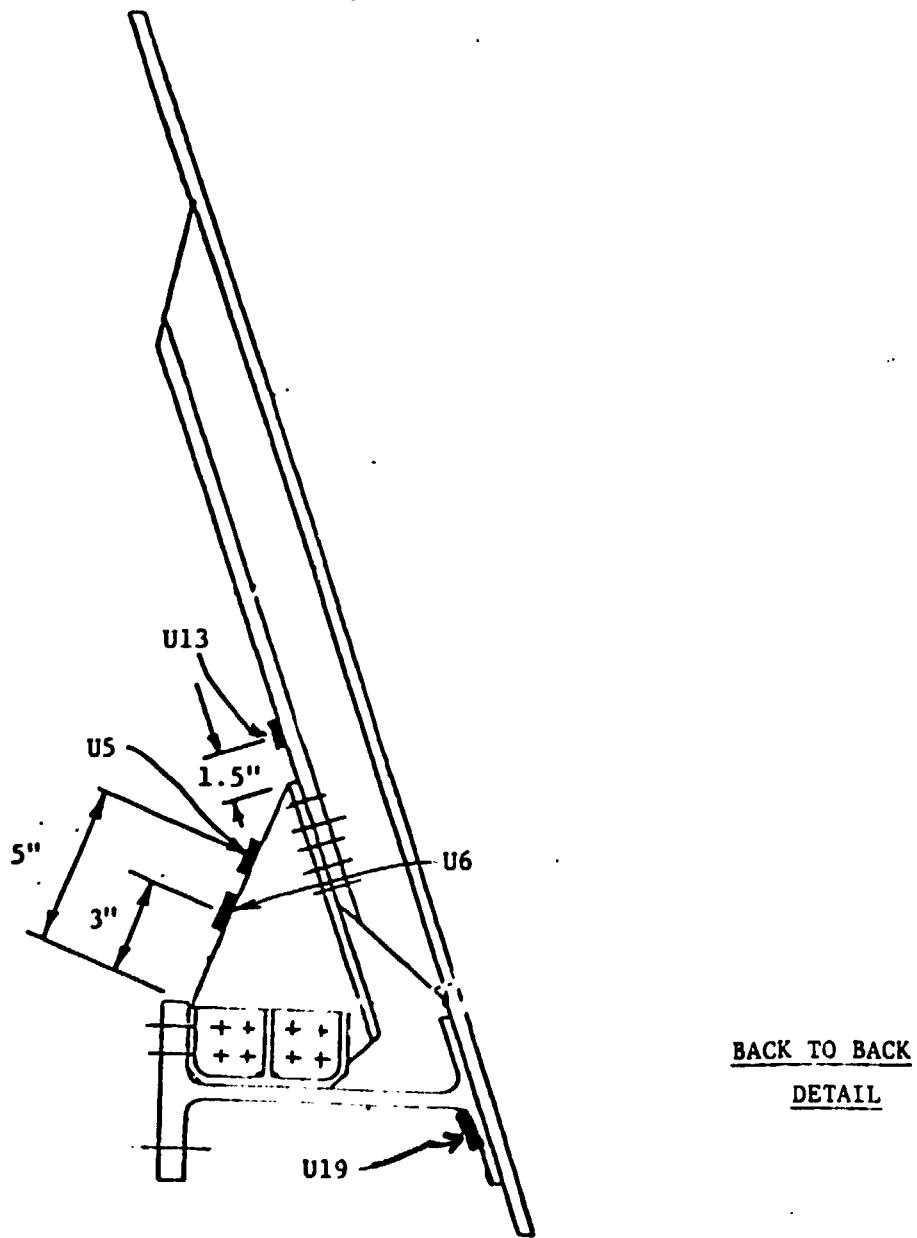
*LOCATED ON OUTER FLANGE WHEN
CLIP WAS REMOVED.

FIGURE 16 INSTRUMENTATION LOCATIONS
AFT RING SEGMENT

STRINGER 1 DETAIL

(NEW CUSSET)

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32 FIGURE 17. INSTRUMENTATION LOCATIONS - AFT RING SEGMENT

STRINGER 2 DETAIL

(OLD GUSSET)

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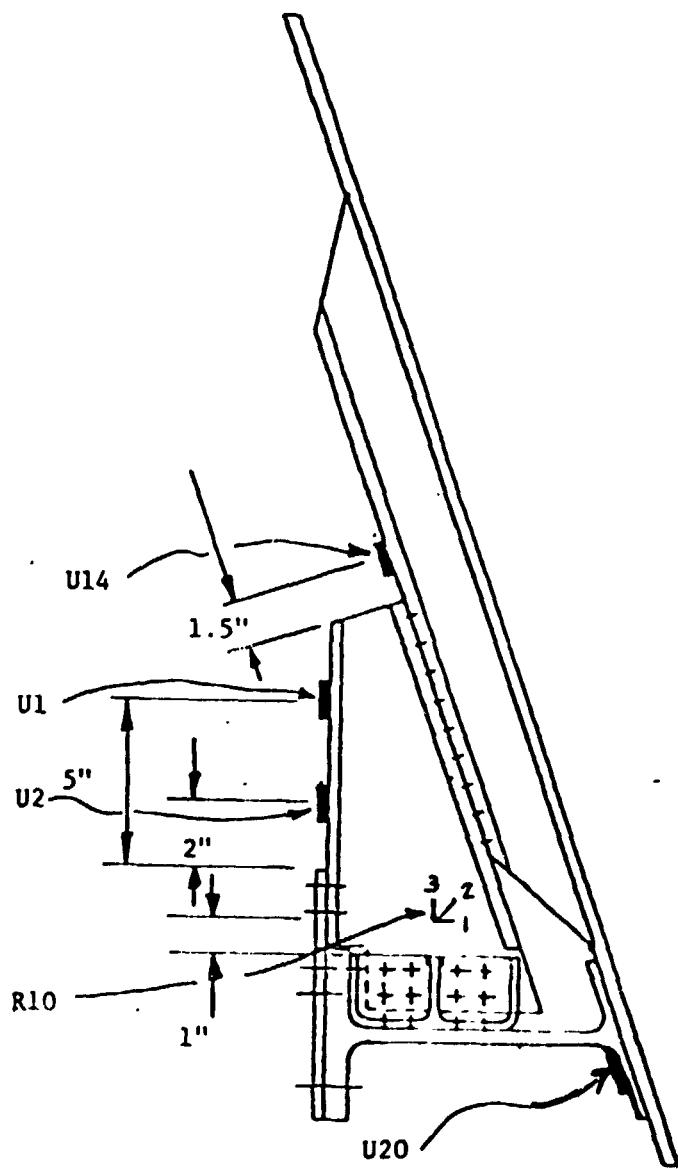


FIGURE 18. INSTRUMENTATION LOCATIONS
AFT RING SEGMENT

STRINGER 3 DETAIL

(NEW GUSSET)

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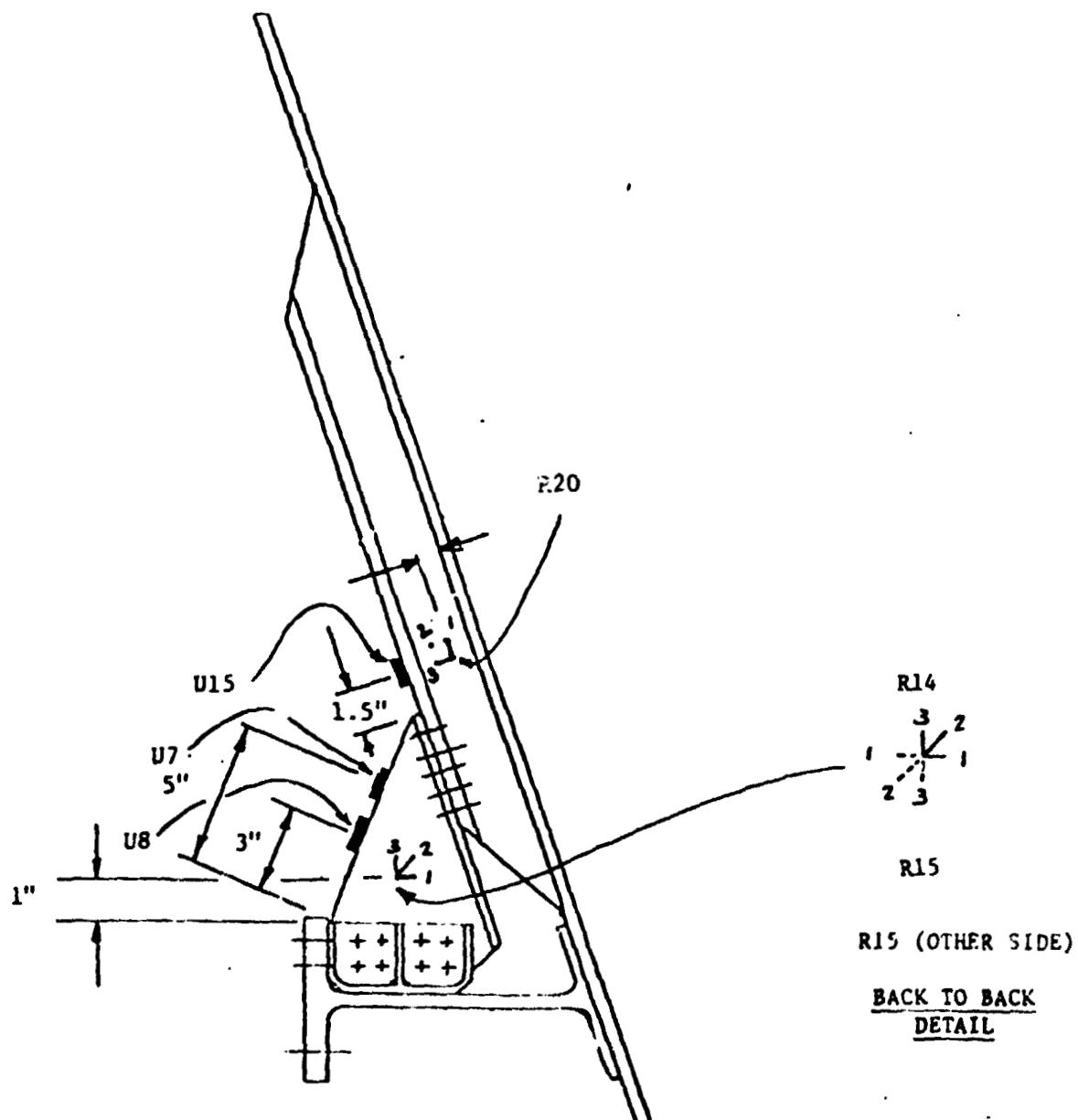


FIGURE 19 - INSTRUMENTATION LOCATIONS - AFT RING SEGMENT

STRINGER 4 DETAIL

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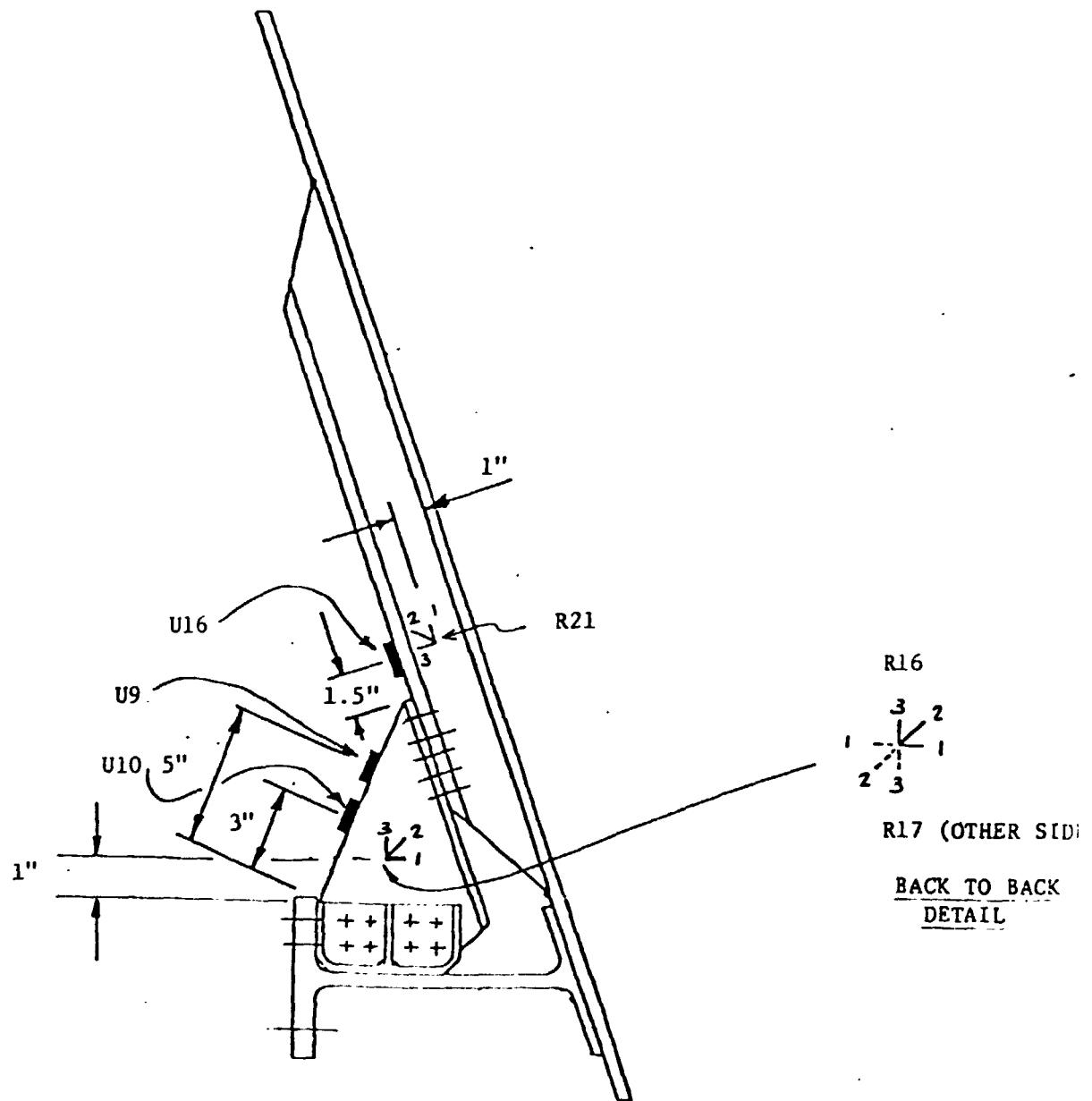


FIGURE 20 - INSTRUMENTATION LOCATIONS - AFT RING SEGMENT

STRINGER 5 DETAIL

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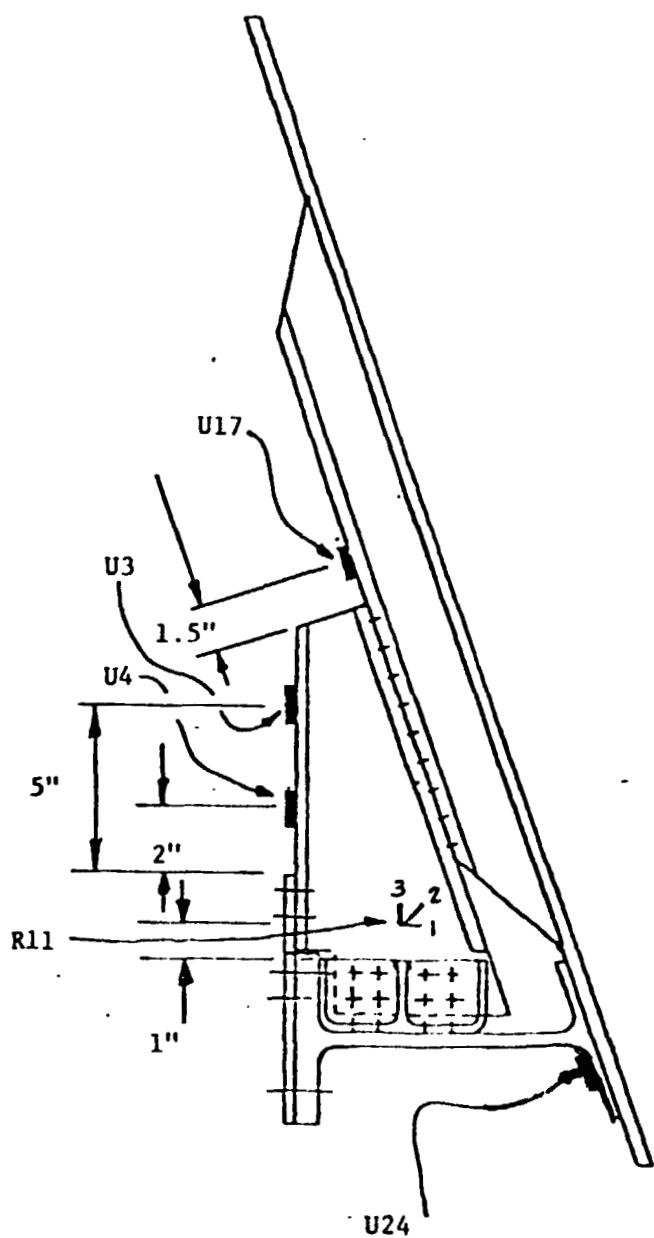


FIGURE 21. INSTRUMENTATION LOCATIONS
AFT RING SEGMENT

STRINGER 6 DETAIL

(NEW GUSSET)

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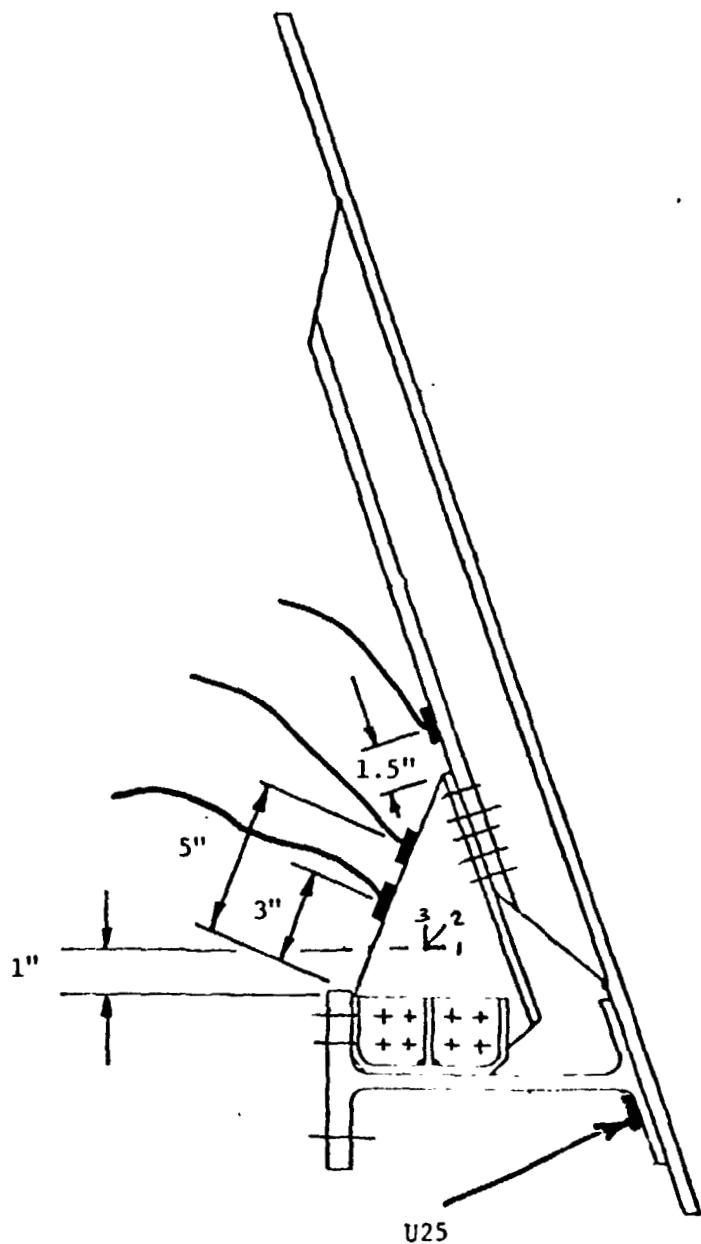
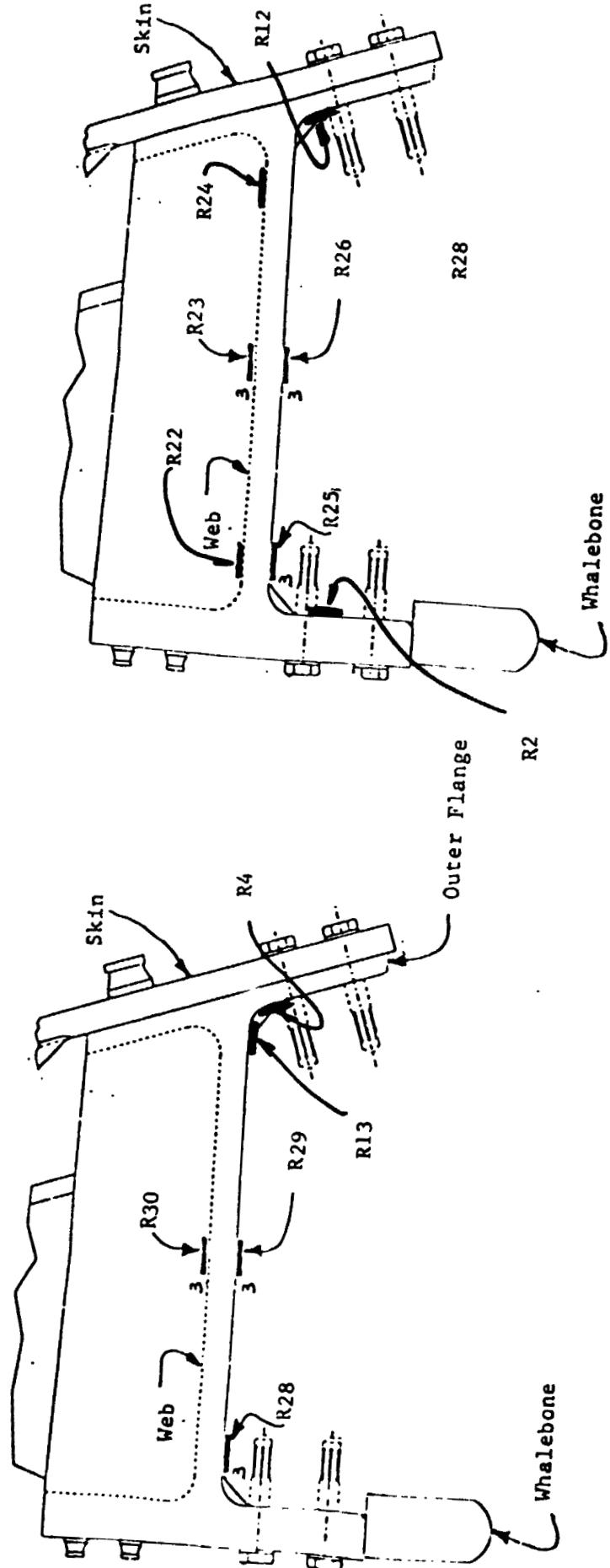


FIGURE 22 - INSTRUMENTATION LOCATIONS AFT RING SEGMENT



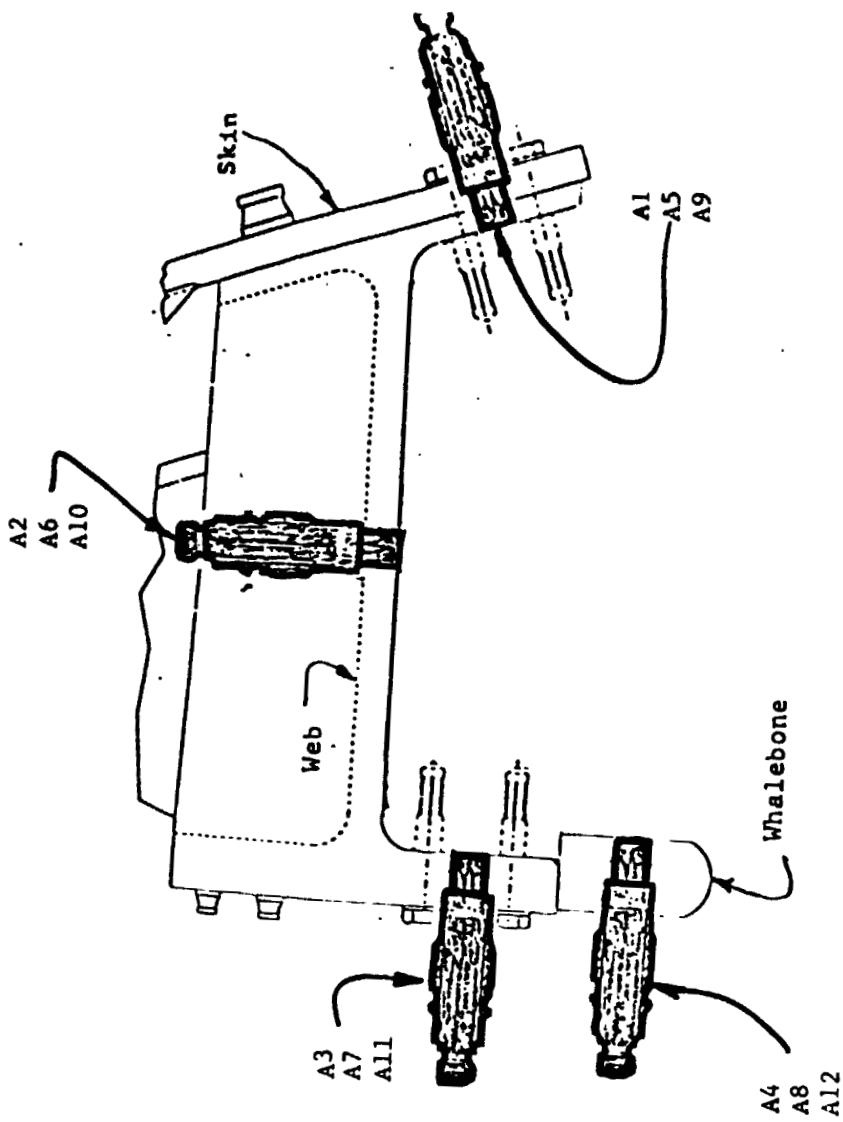
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SECTION G - G

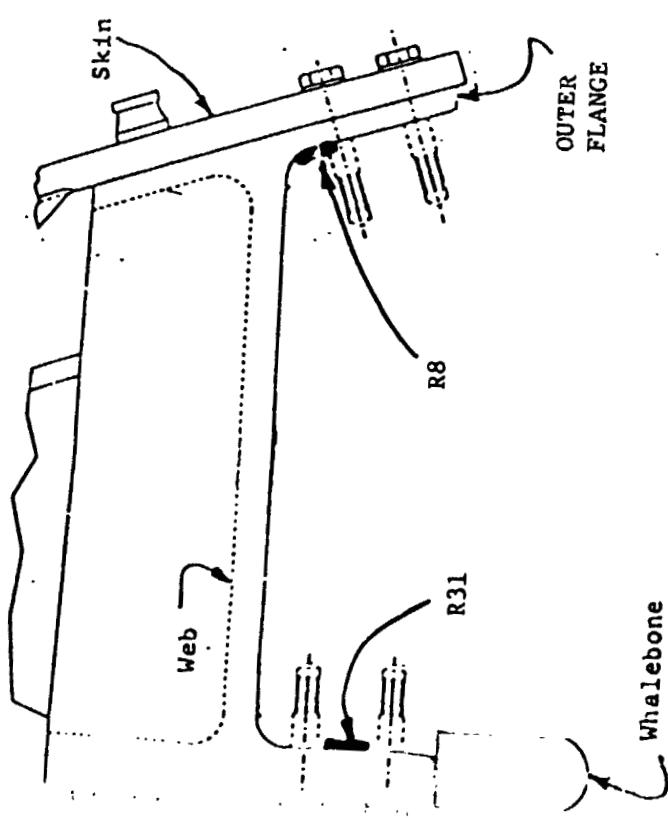
SECTION F - F

FIGURE 23. INSTRUMENTATION LOCATIONS
AFT RING SEGMENT

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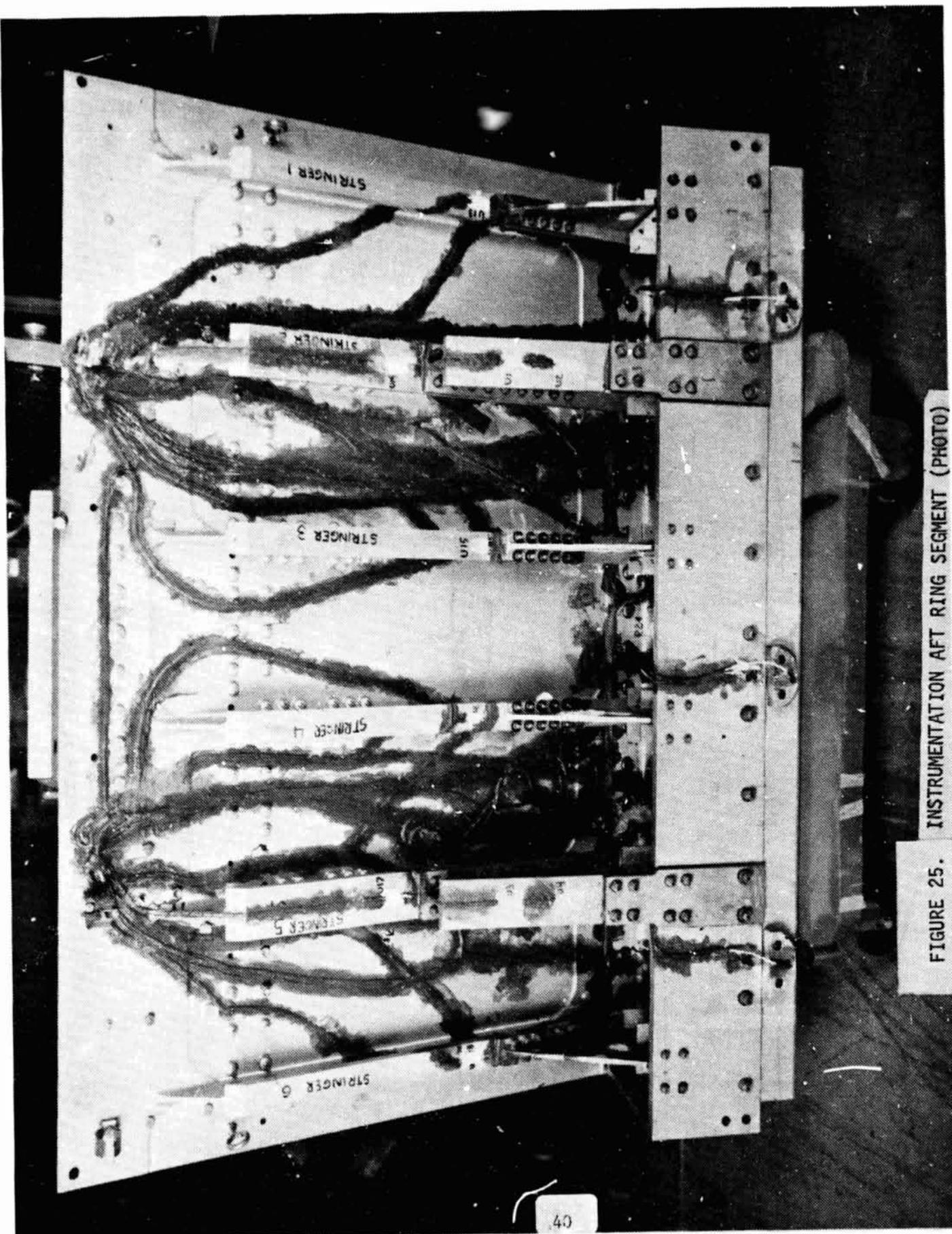
TYPICAL PRESSURE
TRANSDUCER INSTALLATION
SECTION



SECTION H - H

FIGURE 24. INSTRUMENTATION LOCATIONS
AFT RING SEGMENT

FIGURE 25. INSTRUMENTATION AFT RING SEGMENT (PHOTO)



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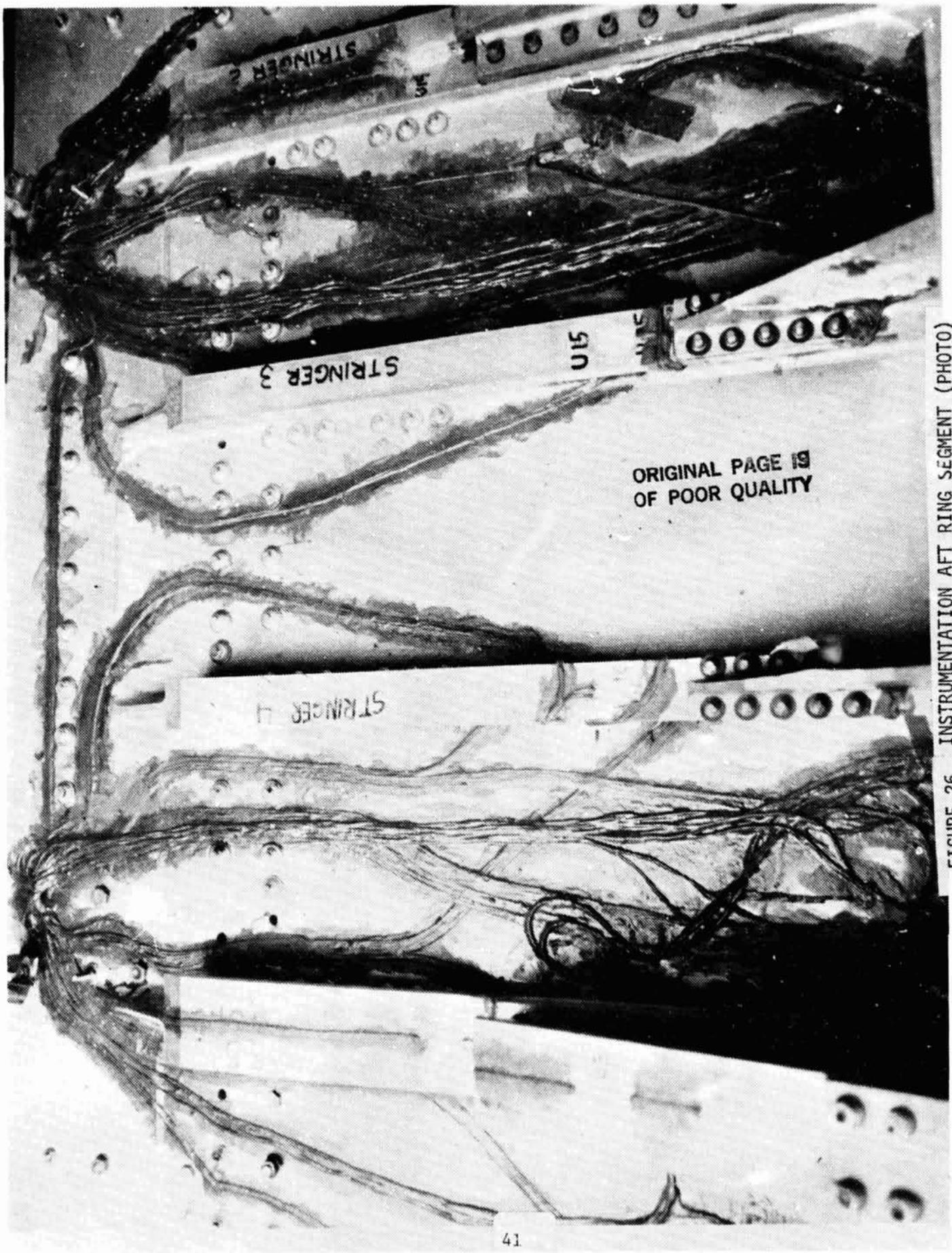


FIGURE 26. INSTRUMENTATION AFT RING SEGMENT (PHOTO)

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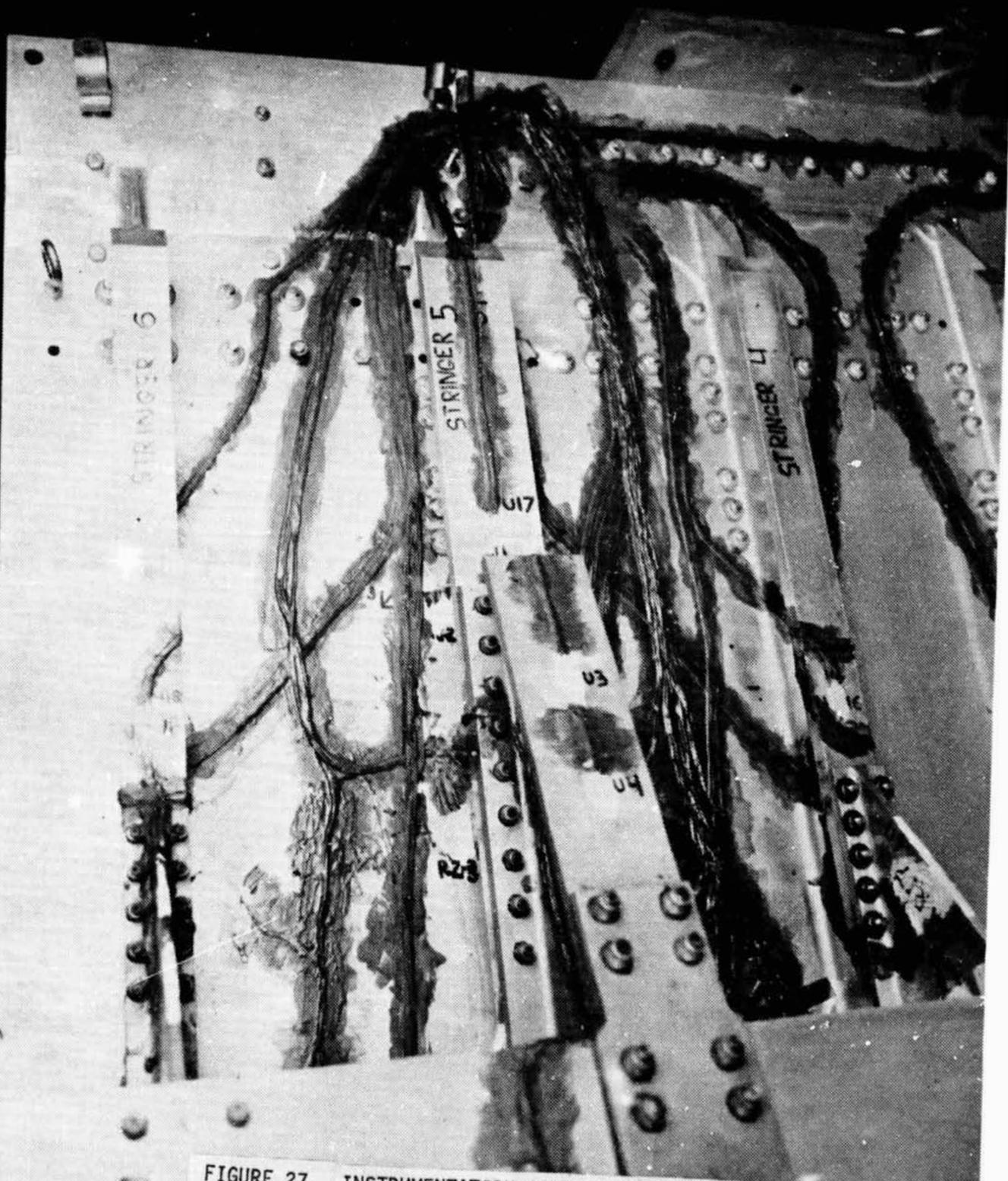


FIGURE 27. INSTRUMENTATION AFT RING SEGMENT (PHOTO)

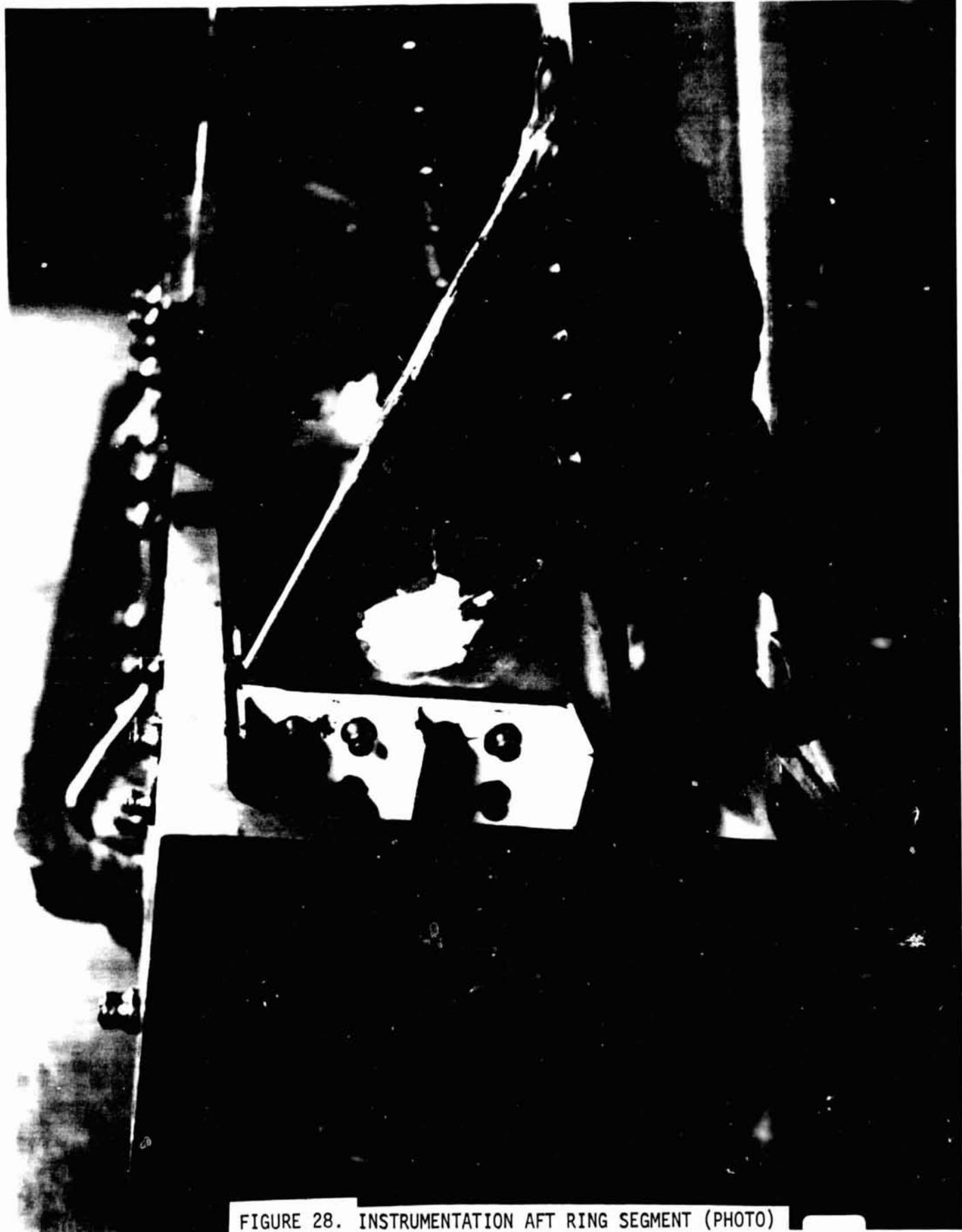


FIGURE 28. INSTRUMENTATION AFT RING SEGMENT (PHOTO)

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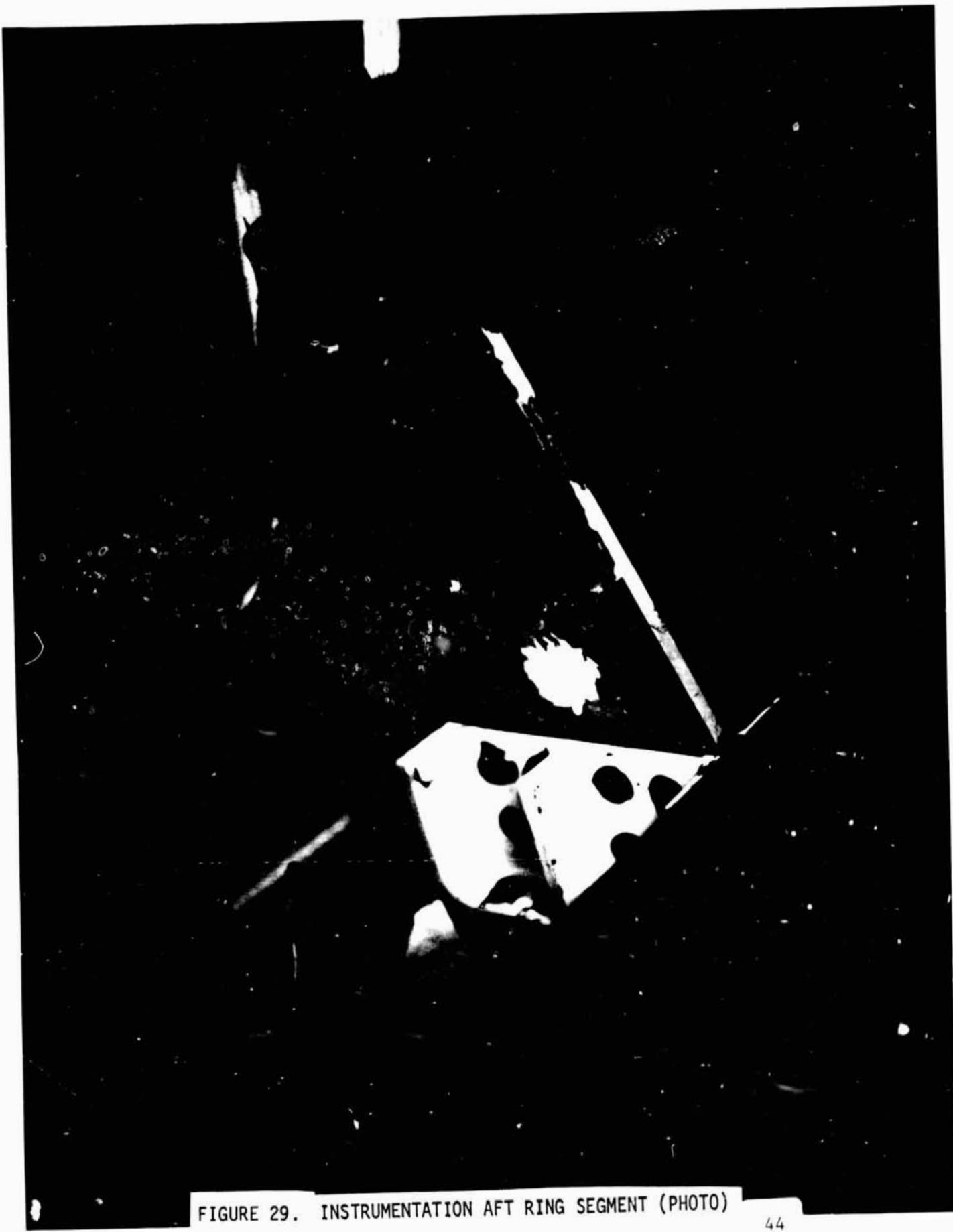


FIGURE 29. INSTRUMENTATION AFT RING SEGMENT (PHOTO)

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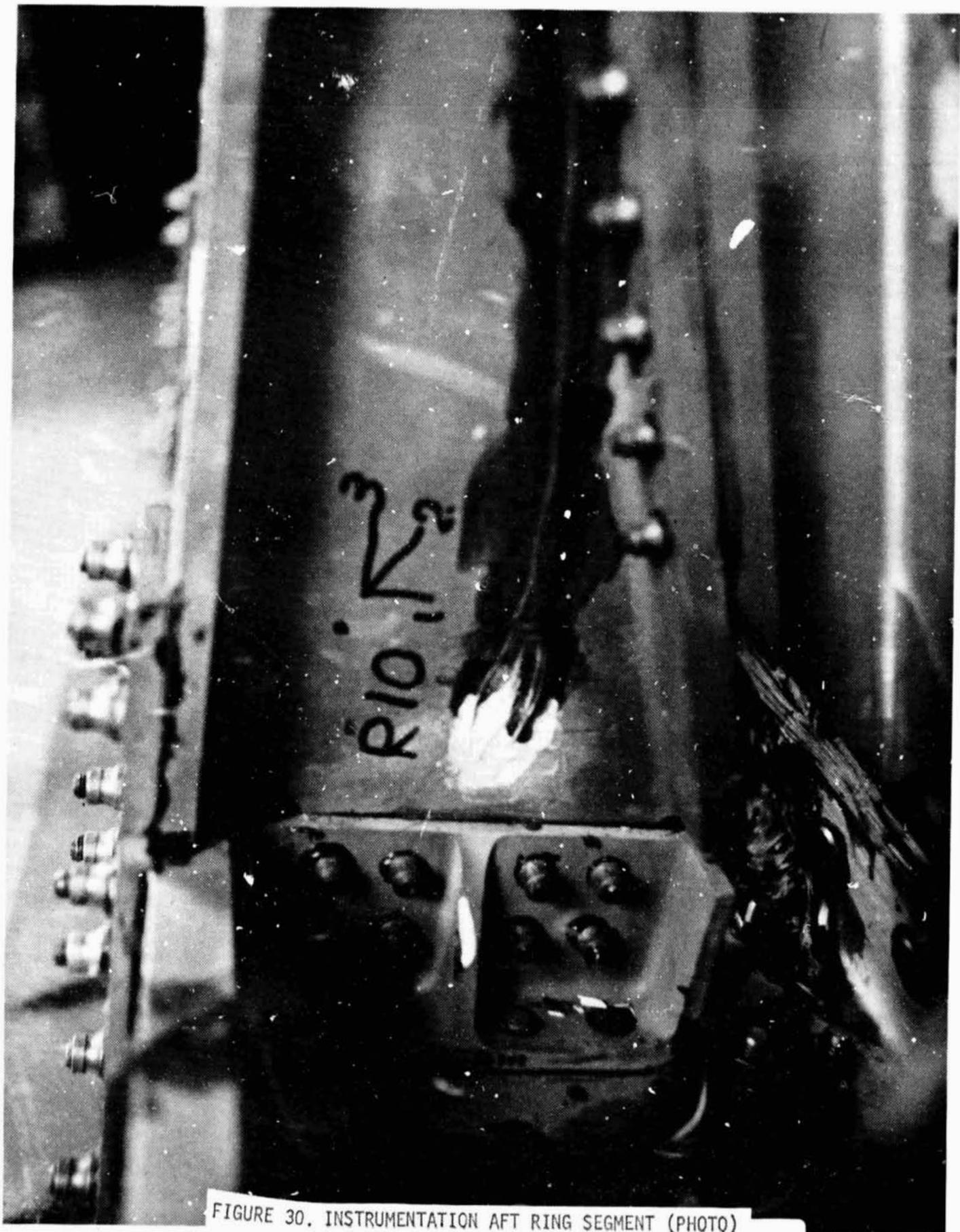


FIGURE 30. INSTRUMENTATION AFT RING SEGMENT (PHOTO)

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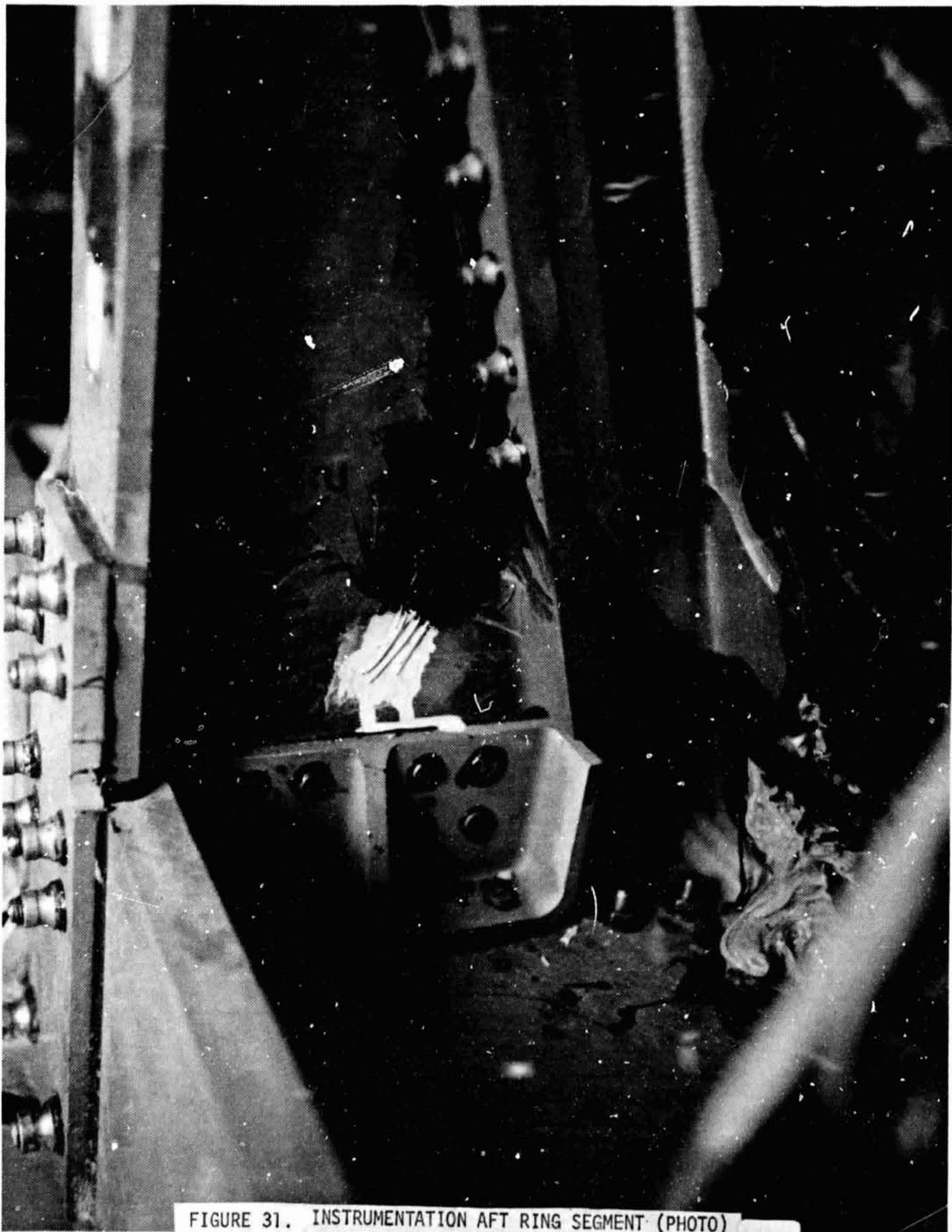


FIGURE 31. INSTRUMENTATION AFT RING SEGMENT (PHOTO)

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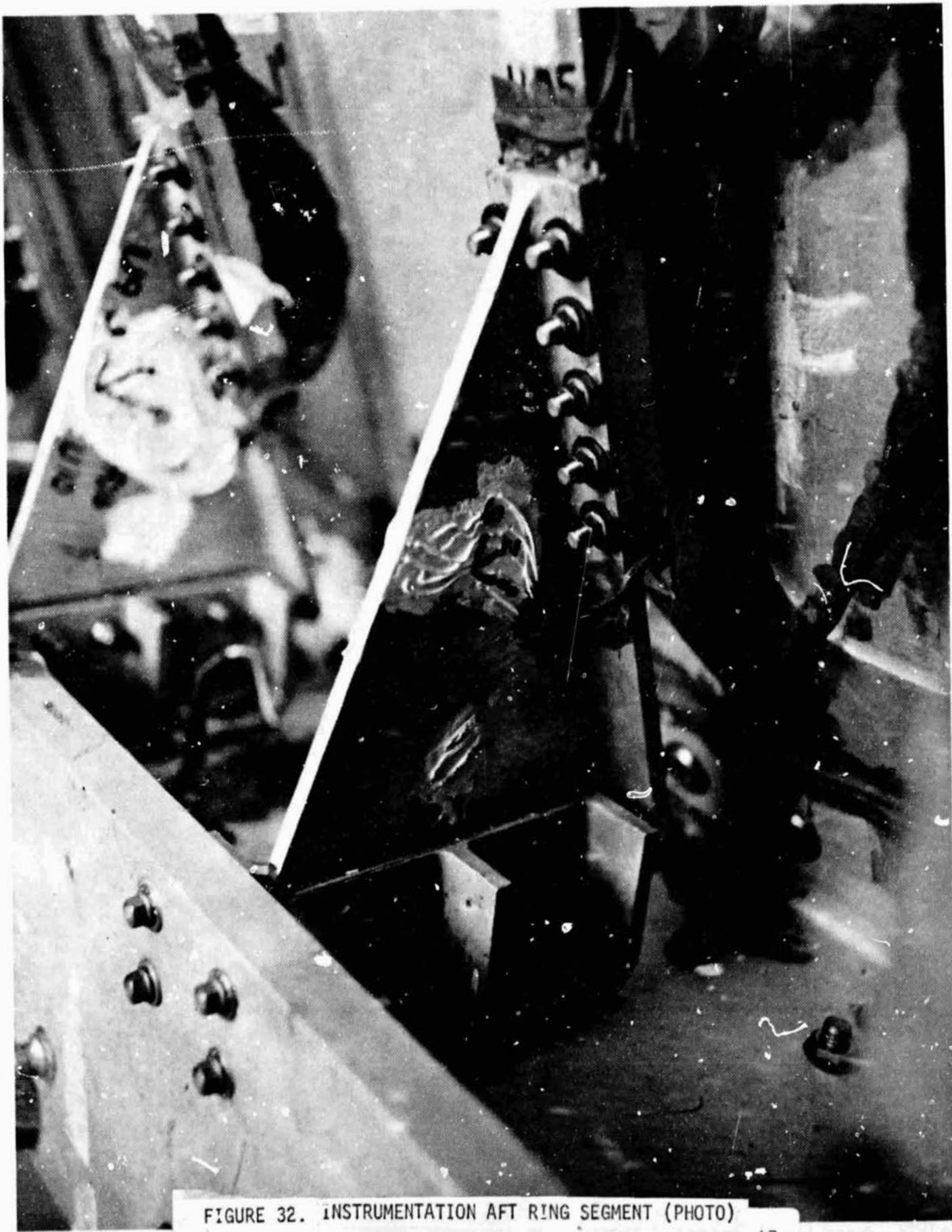


FIGURE 32. INSTRUMENTATION AFT RING SEGMENT (PHOTO)

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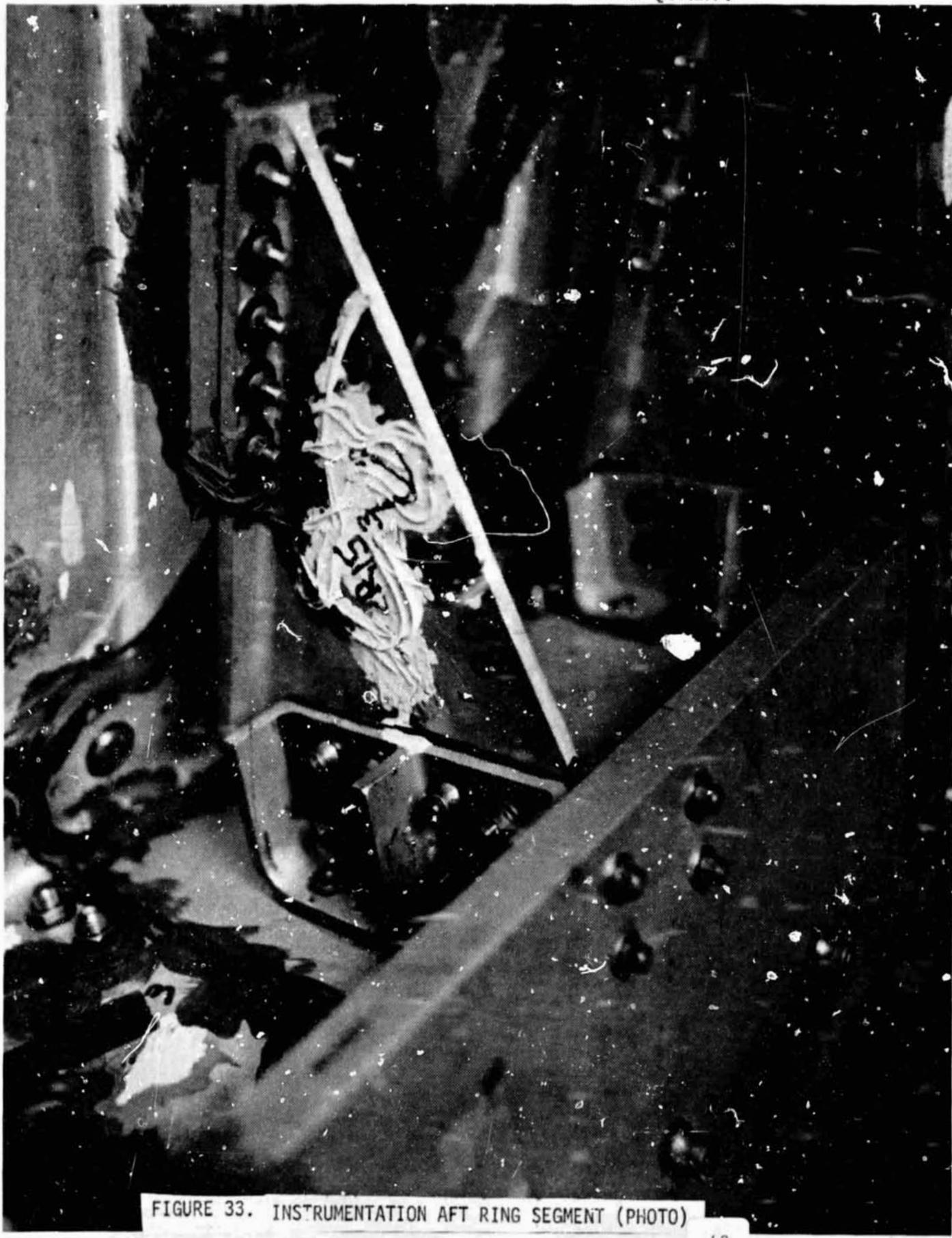


FIGURE 33. INSTRUMENTATION AFT RING SEGMENT (PHOTO)

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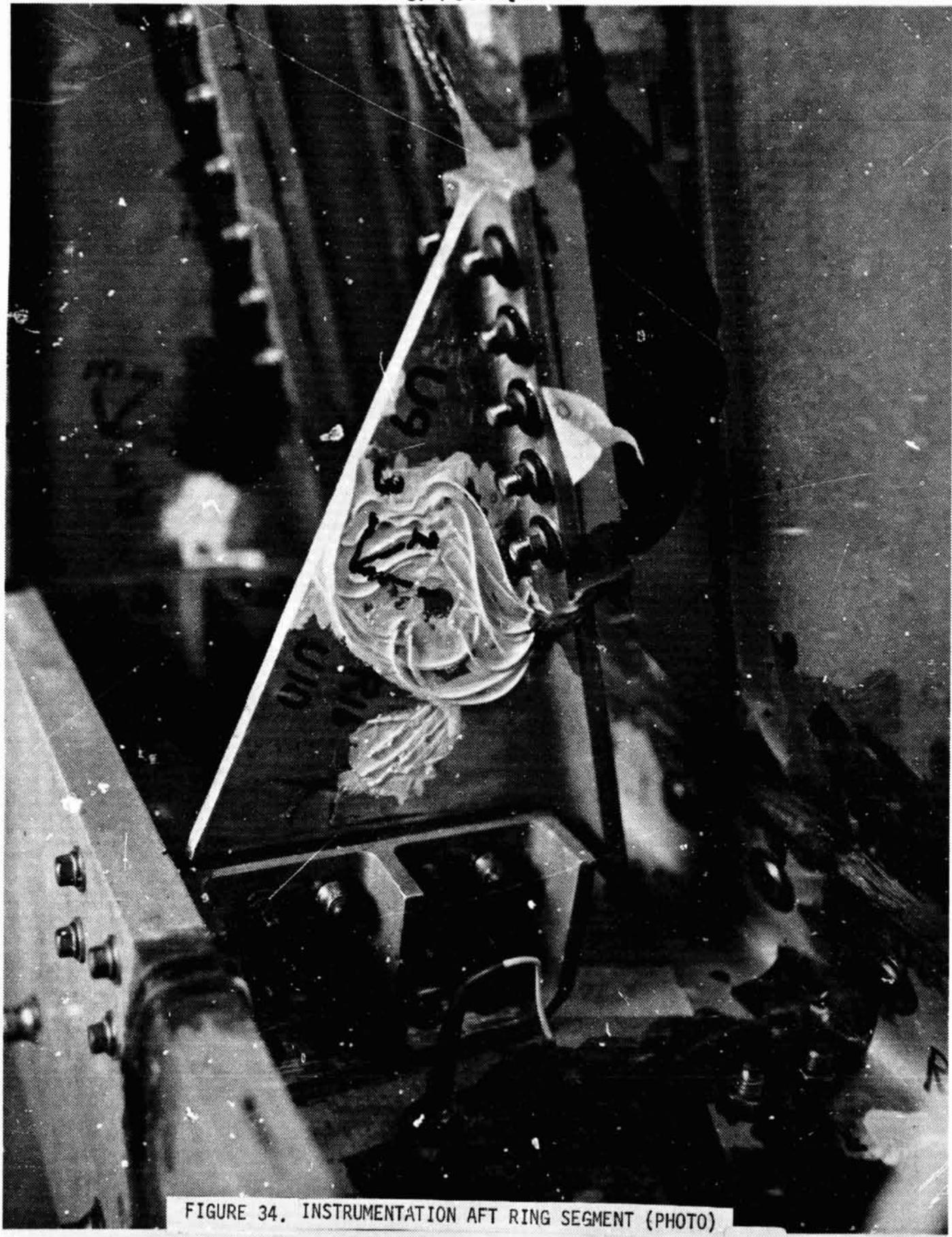


FIGURE 34. INSTRUMENTATION AFT RING SEGMENT (PHOTO)

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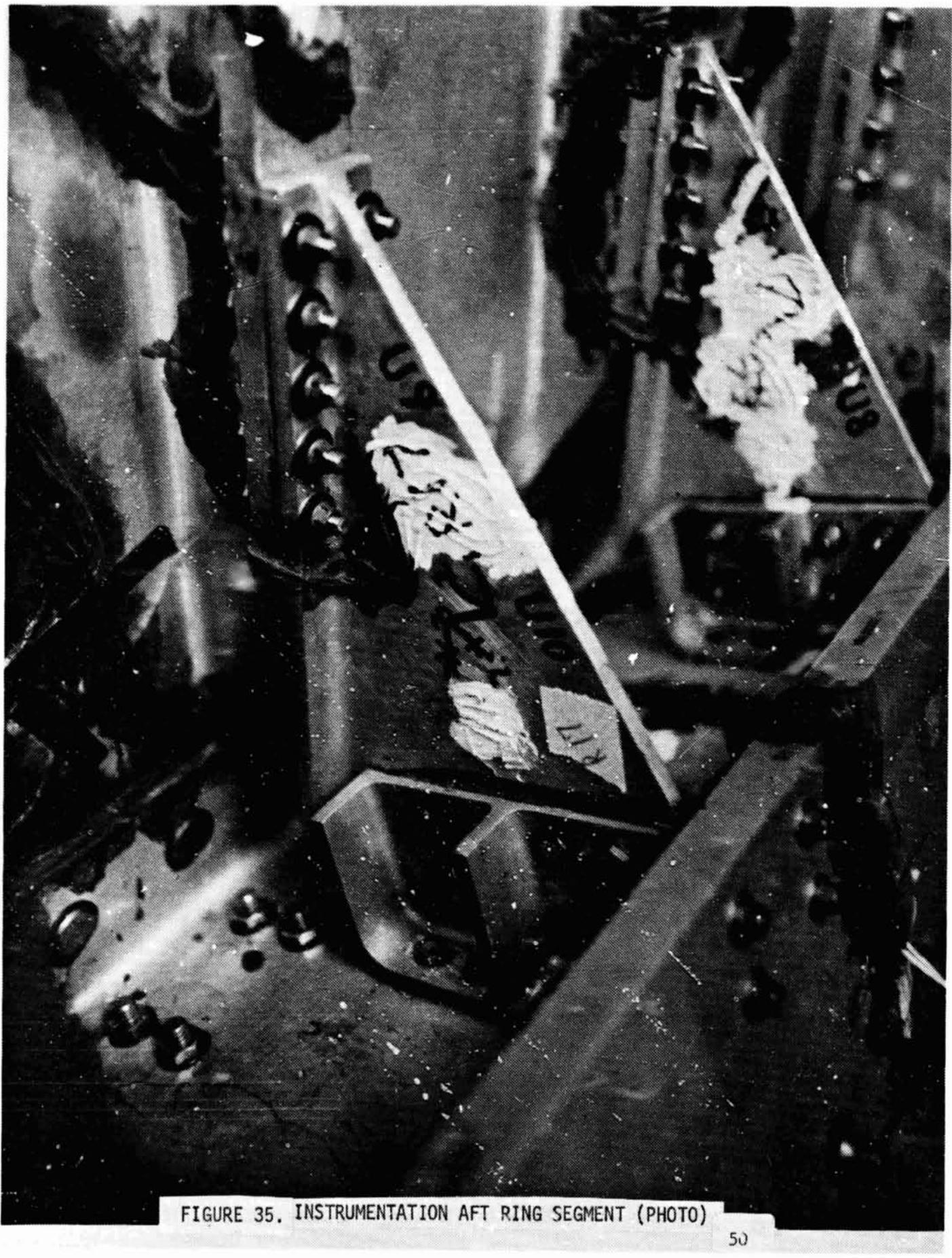


FIGURE 35. INSTRUMENTATION AFT RING SEGMENT (PHOTO)

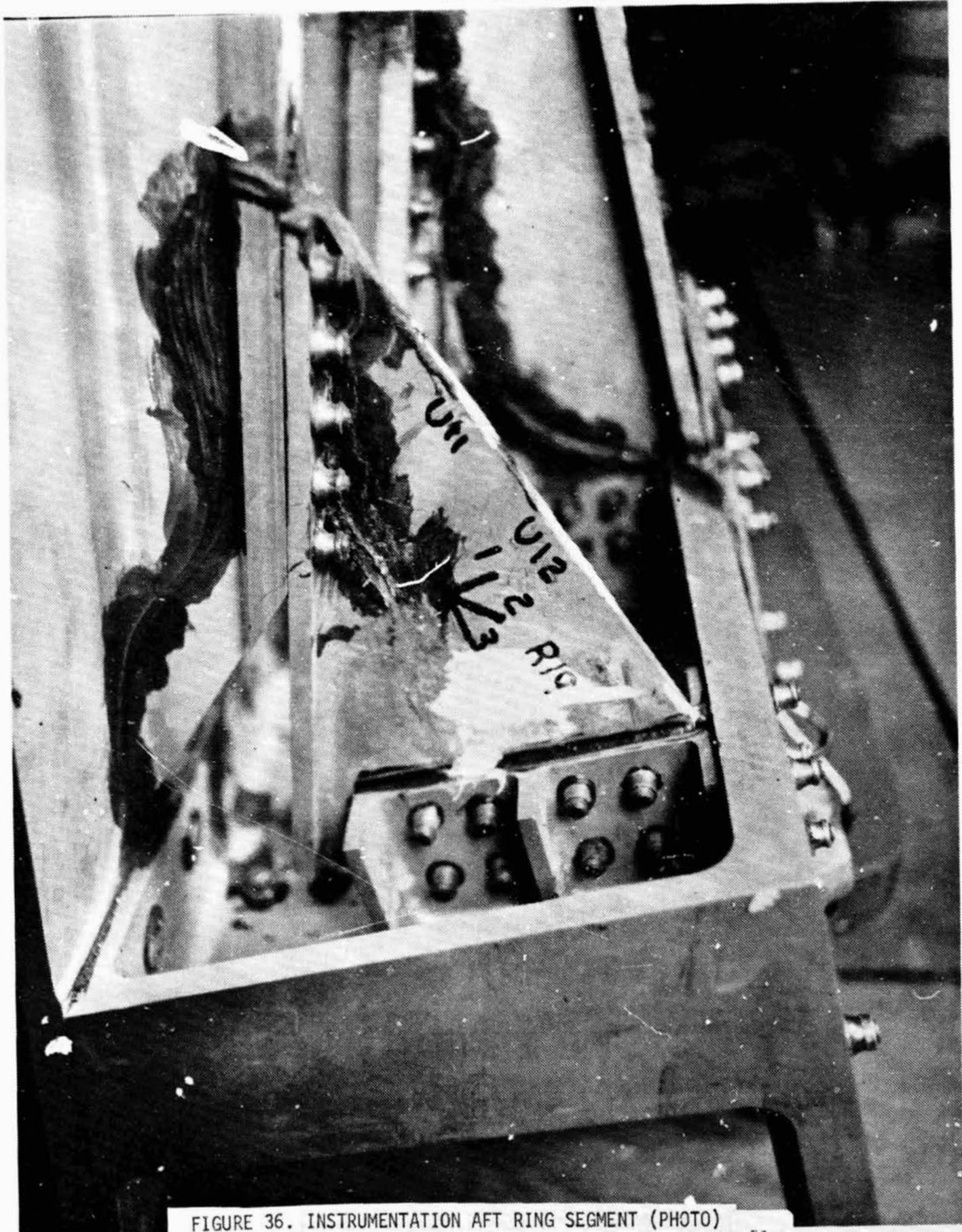


FIGURE 36. INSTRUMENTATION AFT RING SEGMENT (PHOTO)

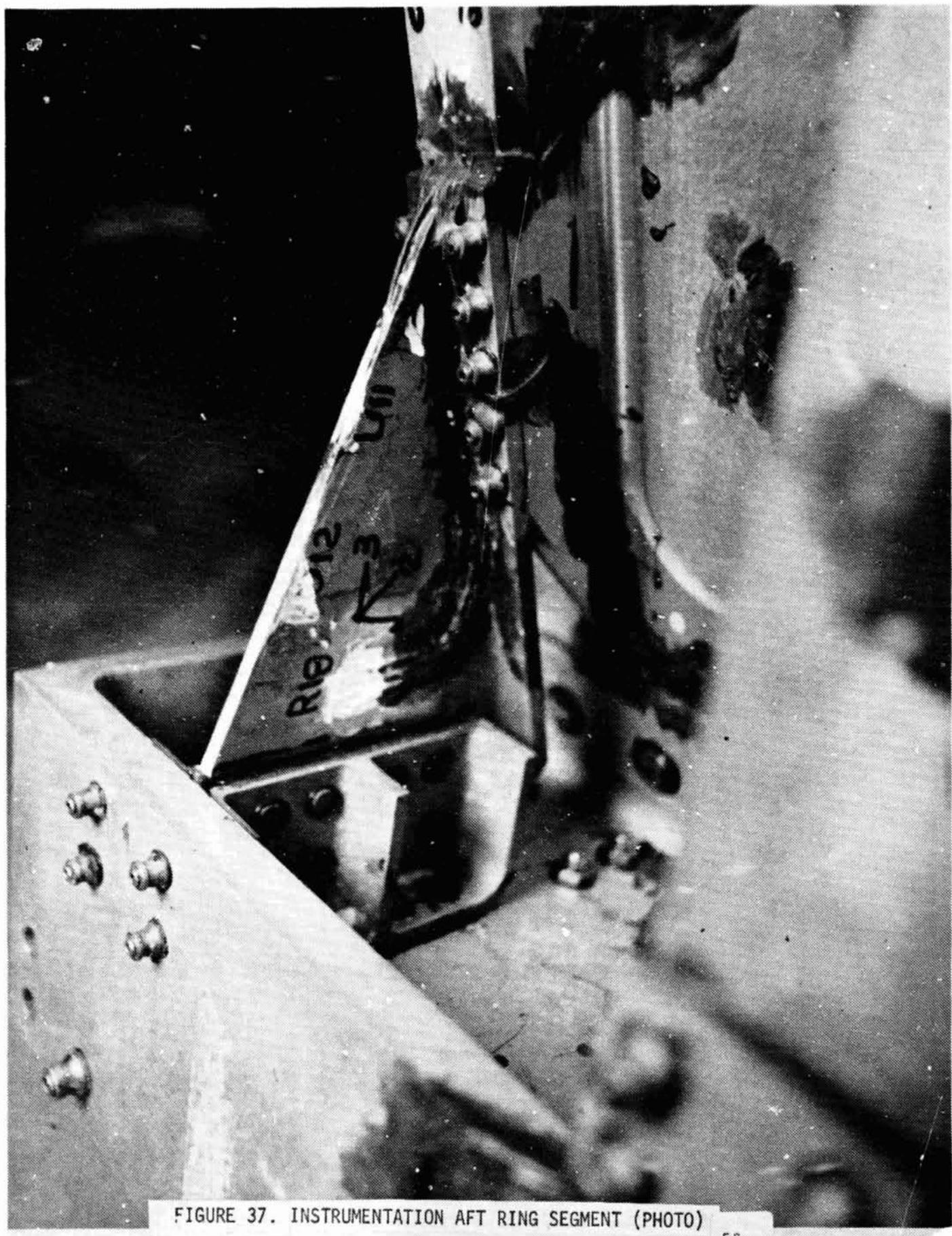


FIGURE 37. INSTRUMENTATION AFT RING SEGMENT (PHOTO)

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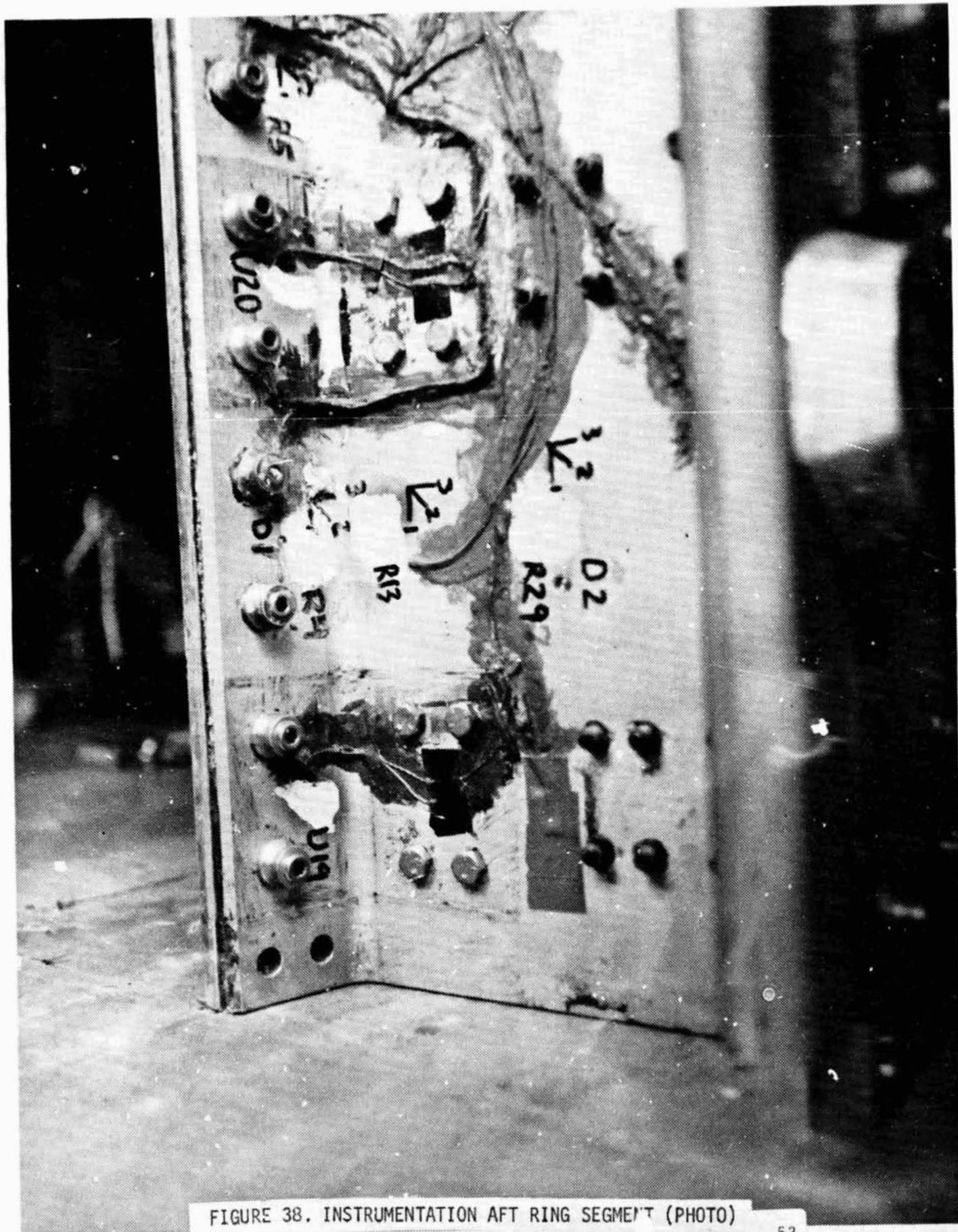


FIGURE 38. INSTRUMENTATION AFT RING SEGMENT (PHOTO)

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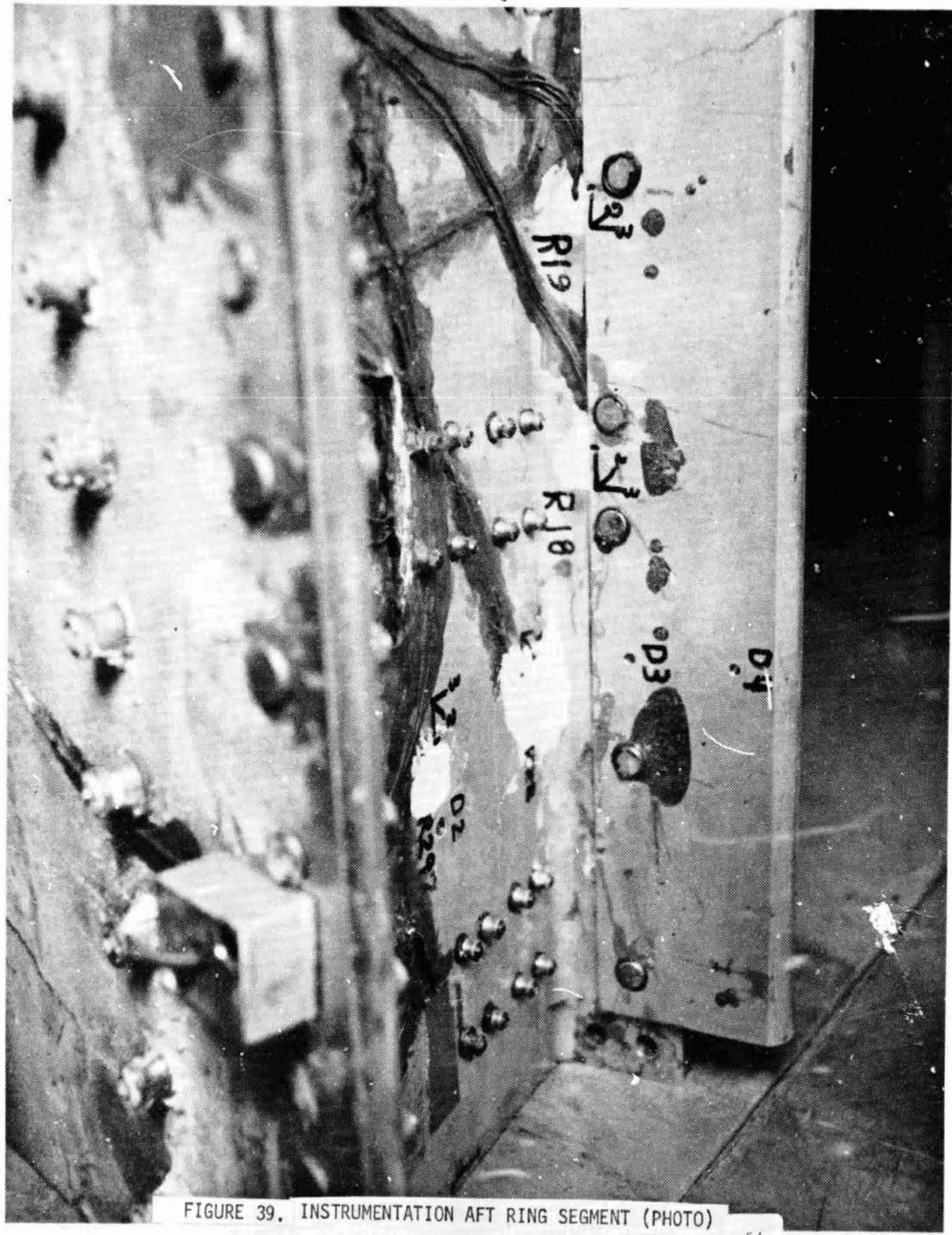


FIGURE 39. INSTRUMENTATION AFT RING SEGMENT (PHOTO)

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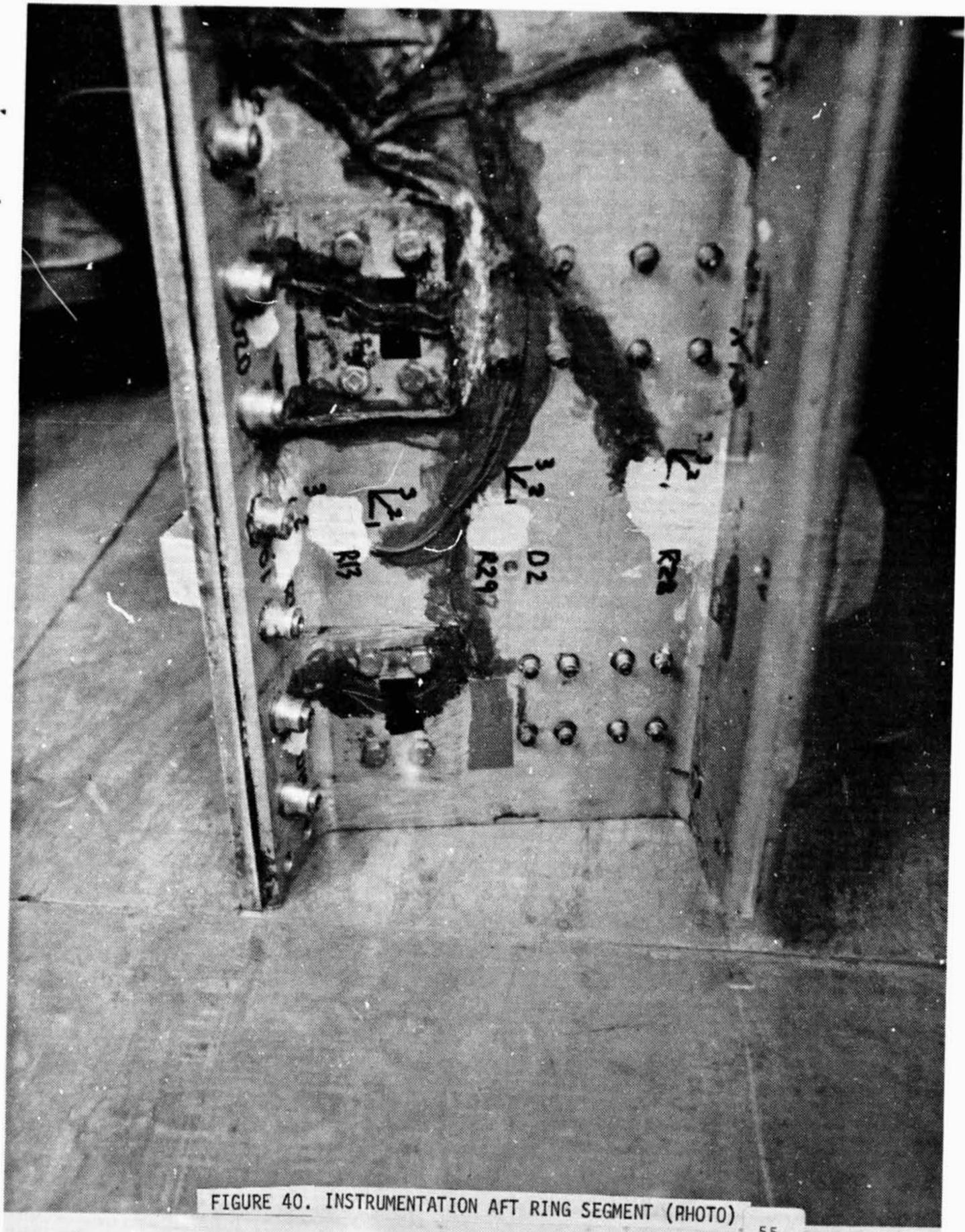


FIGURE 40. INSTRUMENTATION AFT RING SEGMENT (PHOTO)

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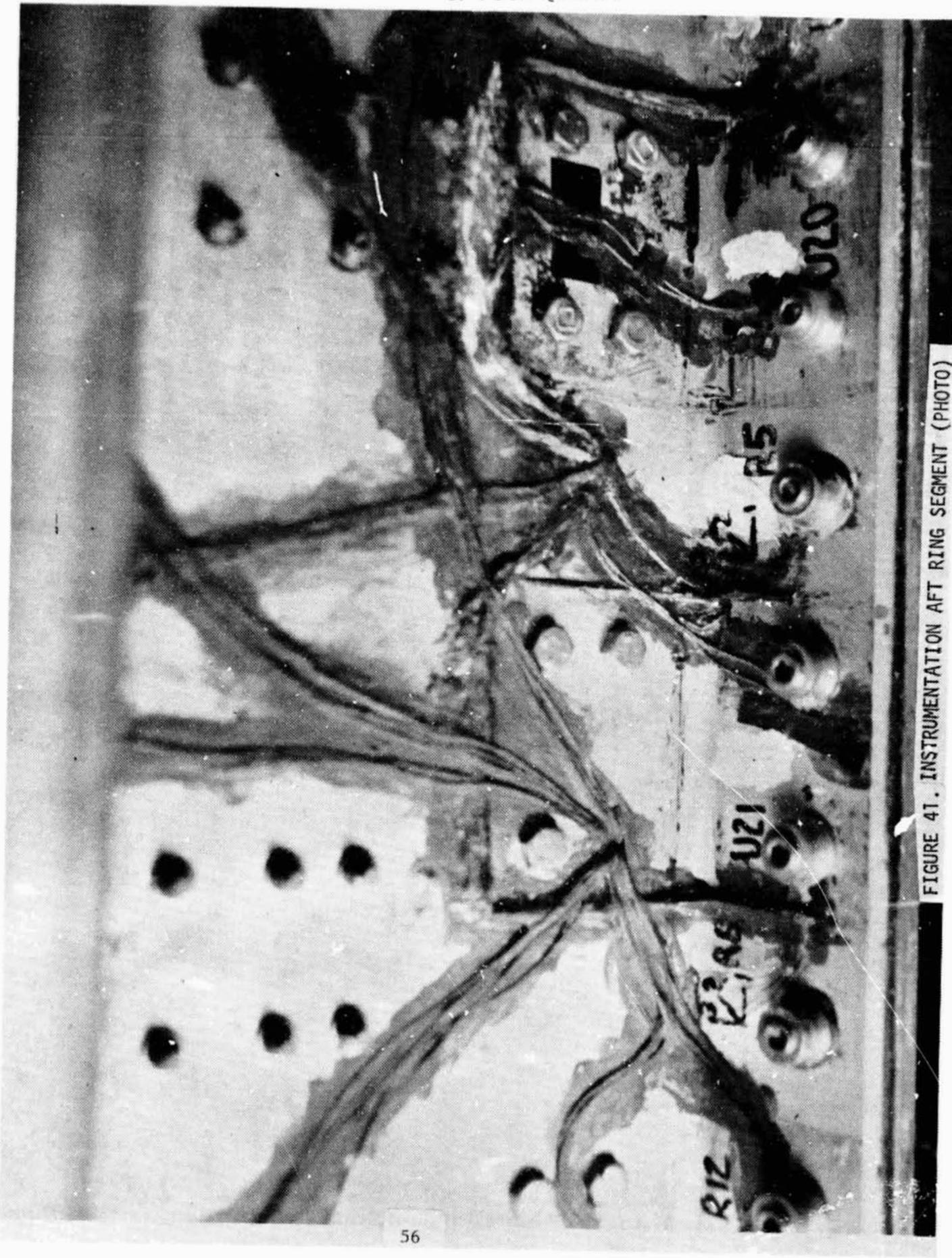


FIGURE 41. INSTRUMENTATION AFT RING SEGMENT (PHOTO)

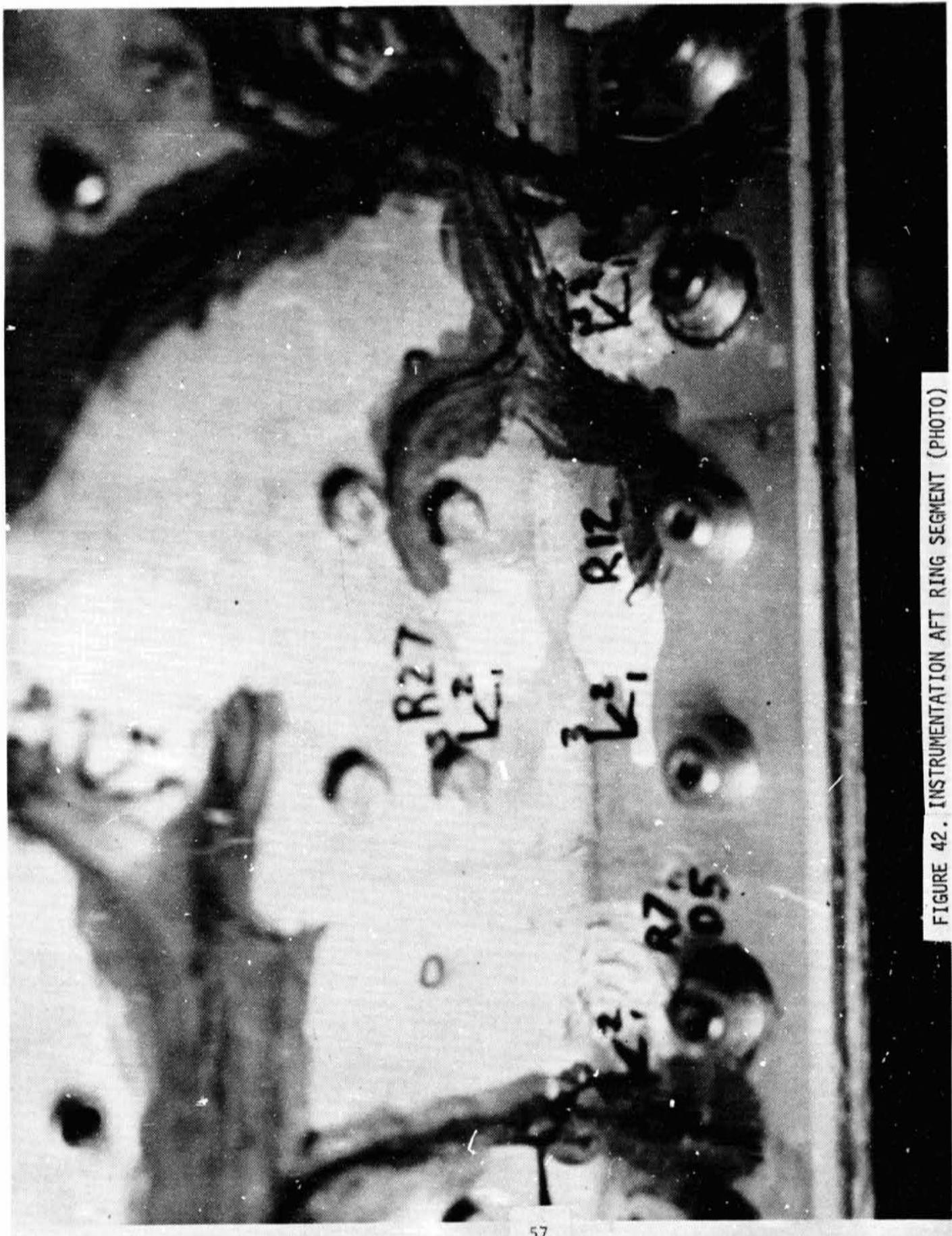


FIGURE 42. INSTRUMENTATION AFT RING SEGMENT (PHOTO)

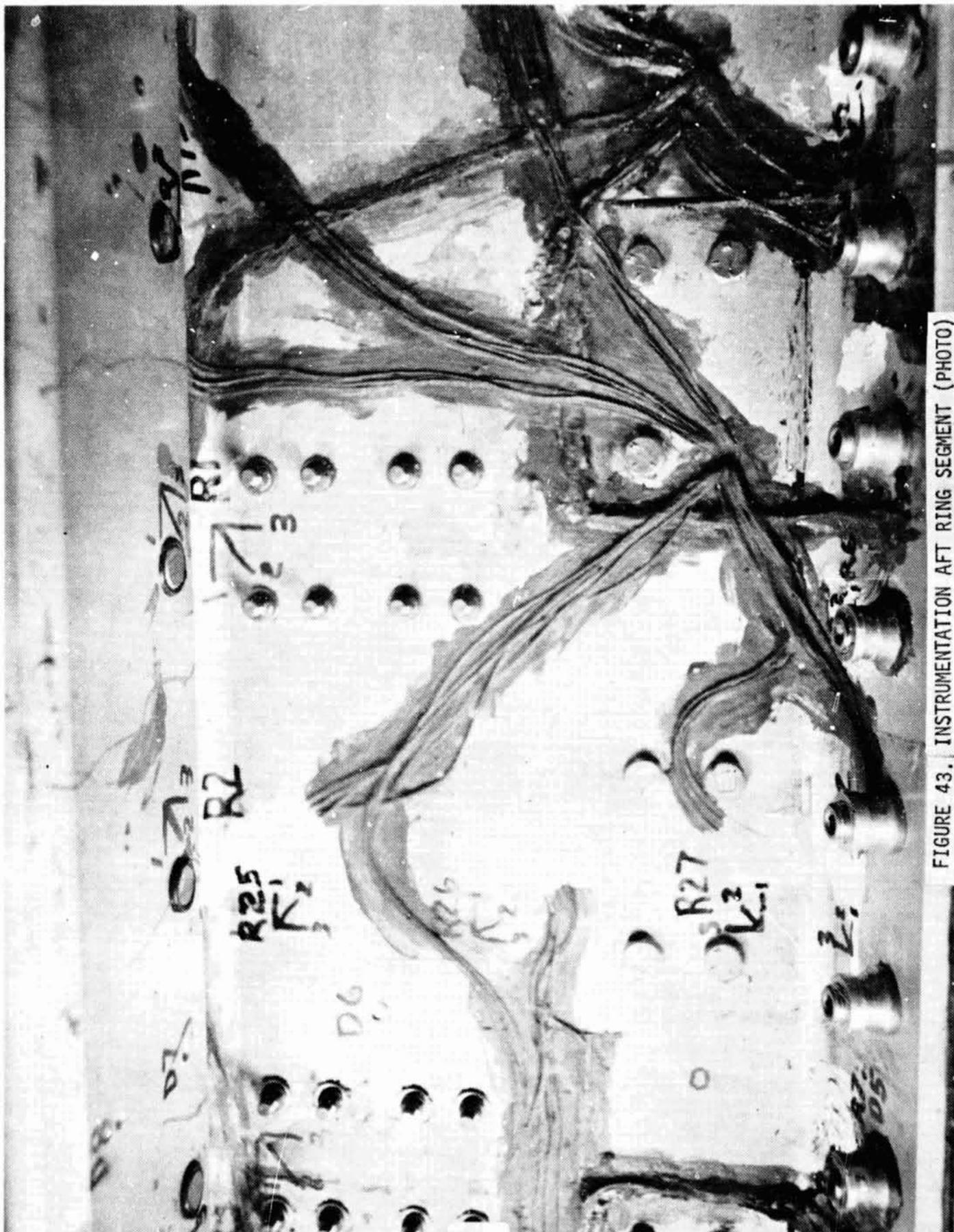


FIGURE 43. INSTRUMENTATION AFT RING SEGMENT (PHOTO)

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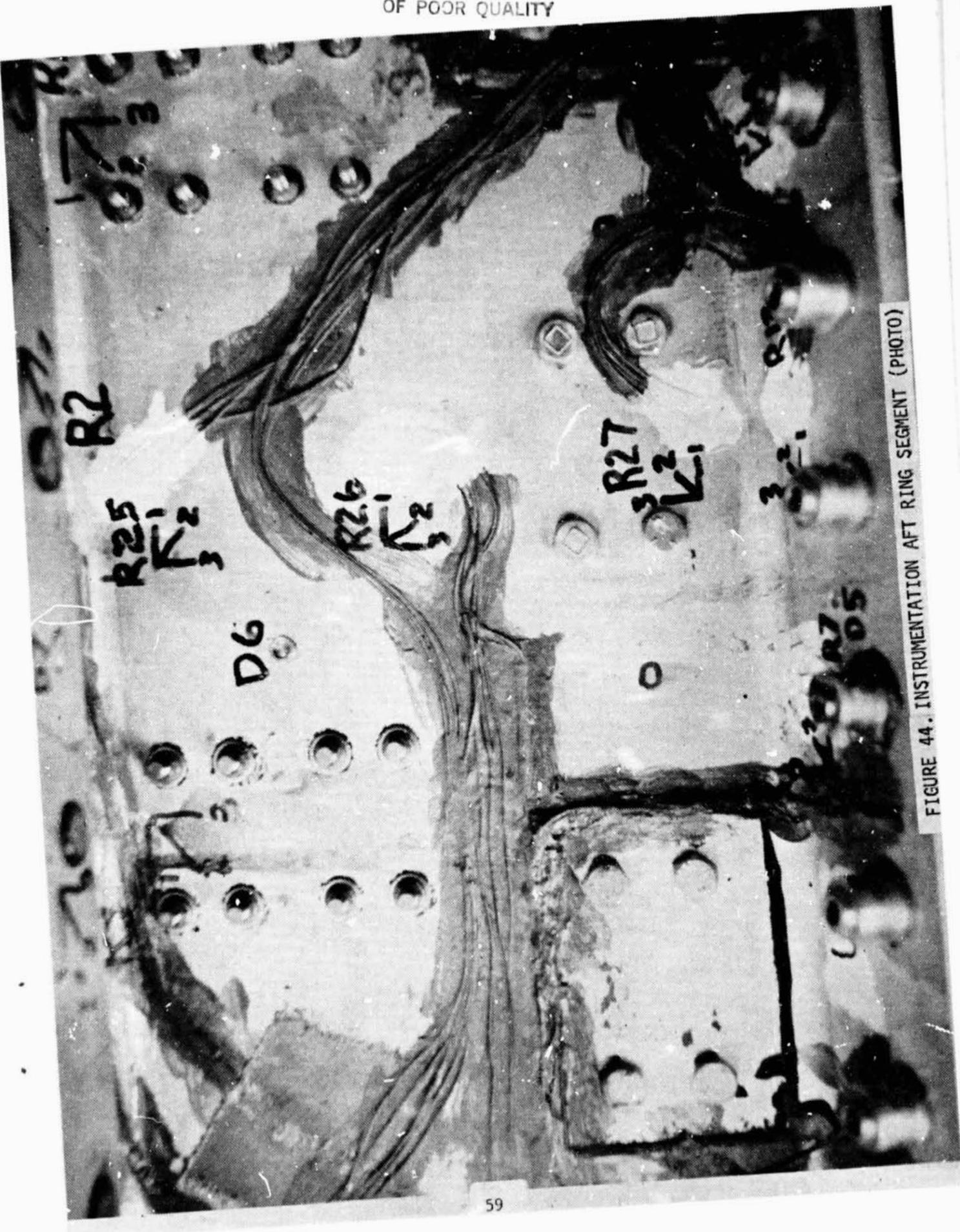


FIGURE 44. INSTRUMENTATION AFT RING SEGMENT (PHOTO)

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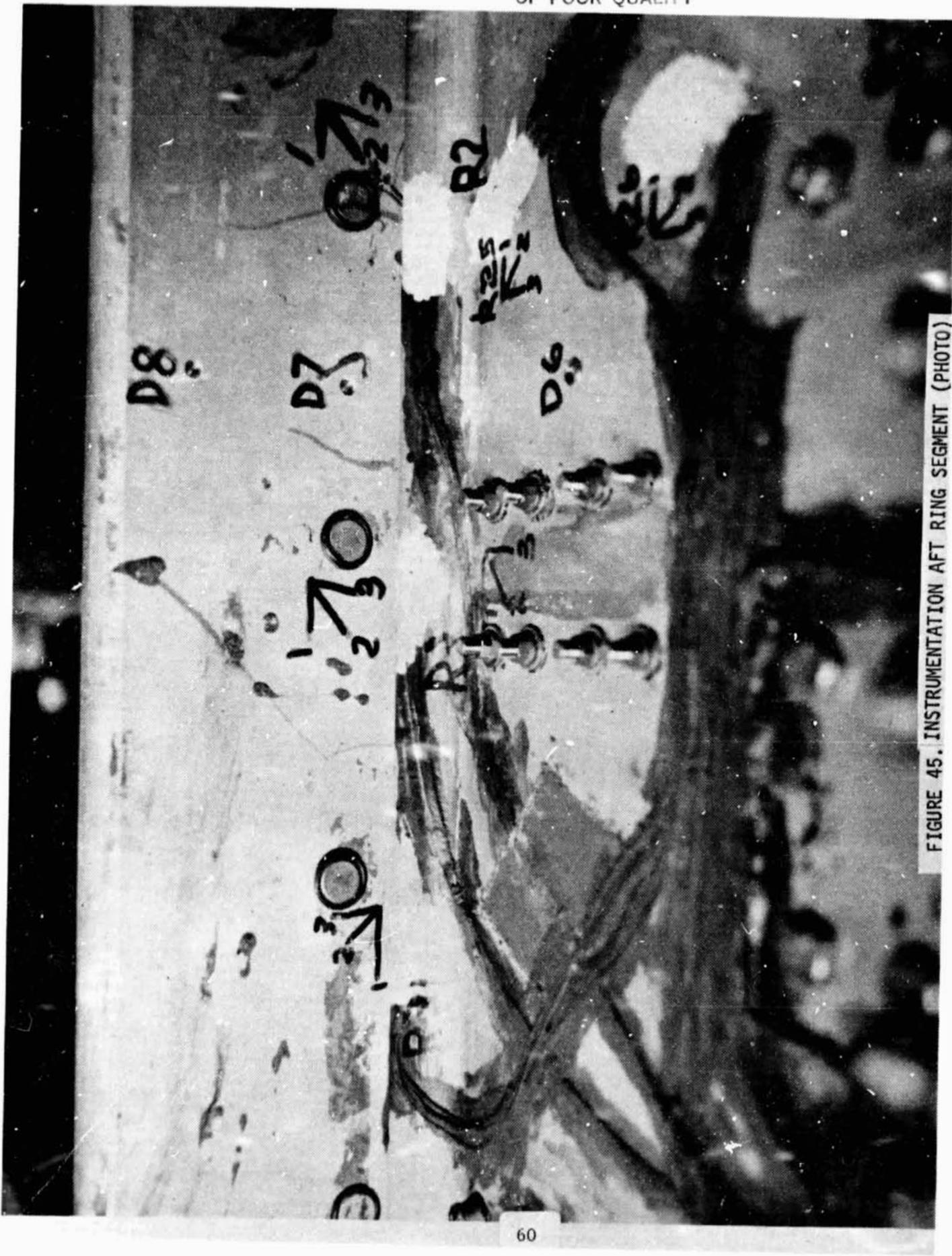


FIGURE 45. INSTRUMENTATION AFT RING SEGMENT (PHOTO)

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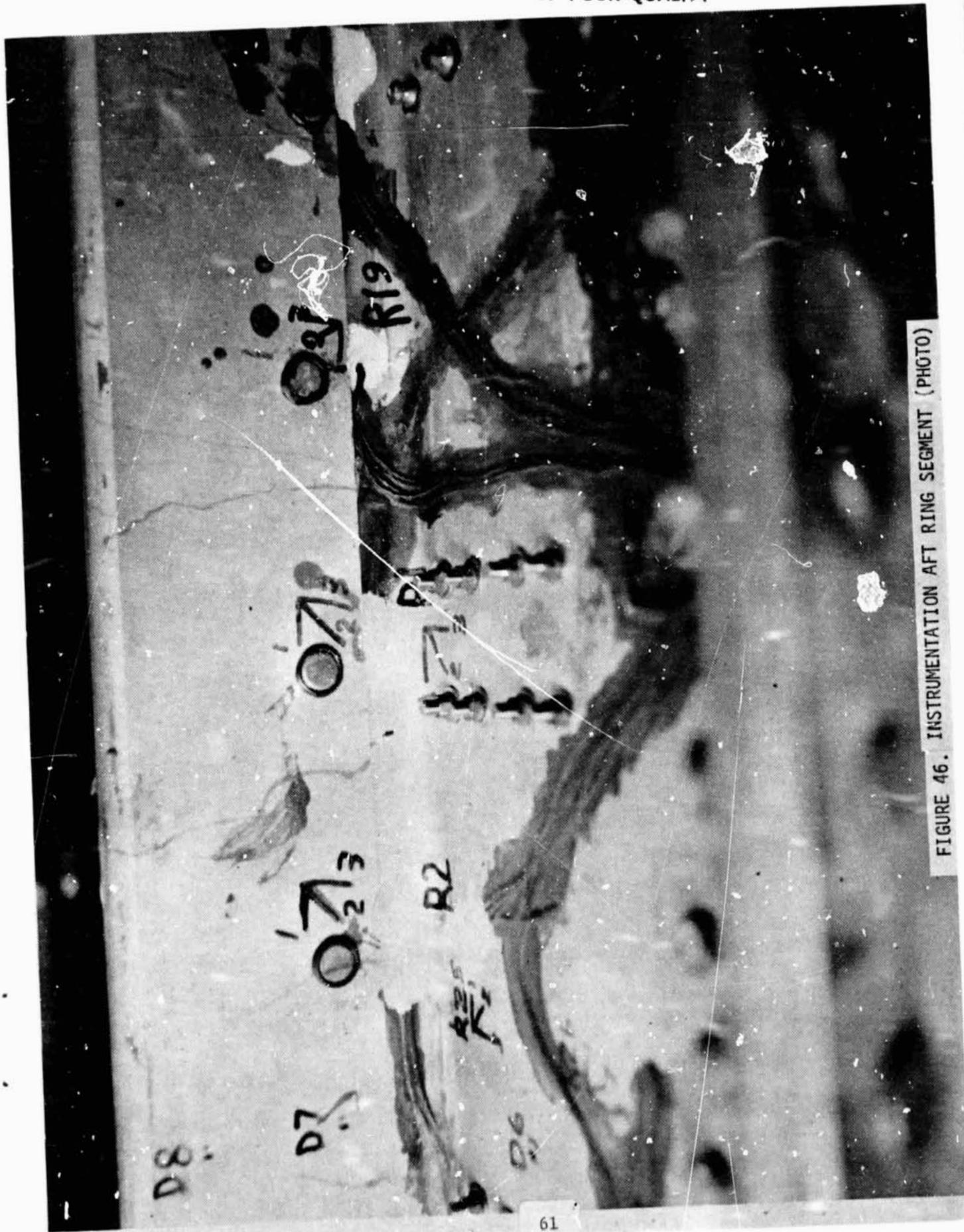


FIGURE 46. INSTRUMENTATION AFT RING SEGMENT (PHOTO)

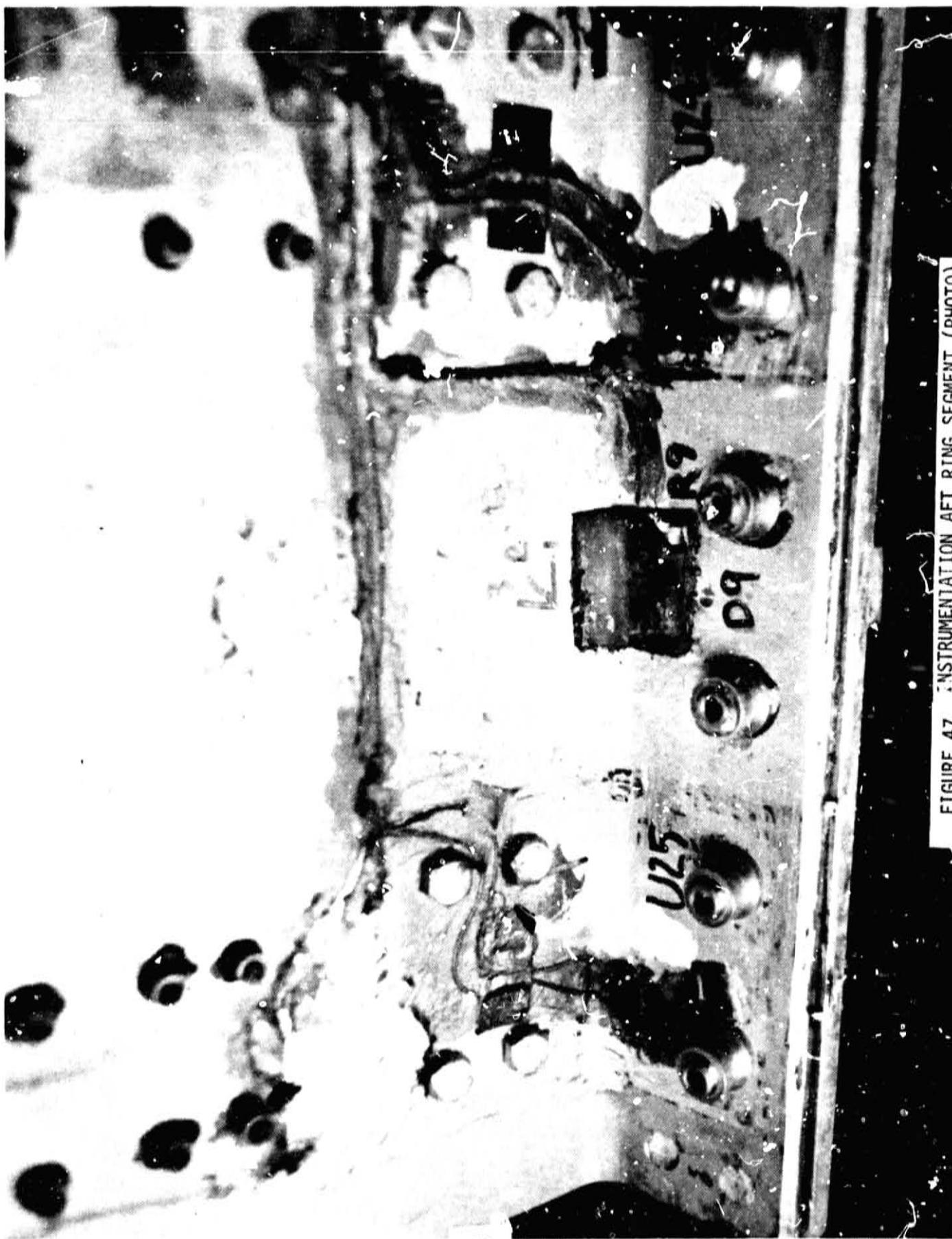


FIGURE 47. INSTRUMENTATION AFT RING SEGMENT (PHOTO)

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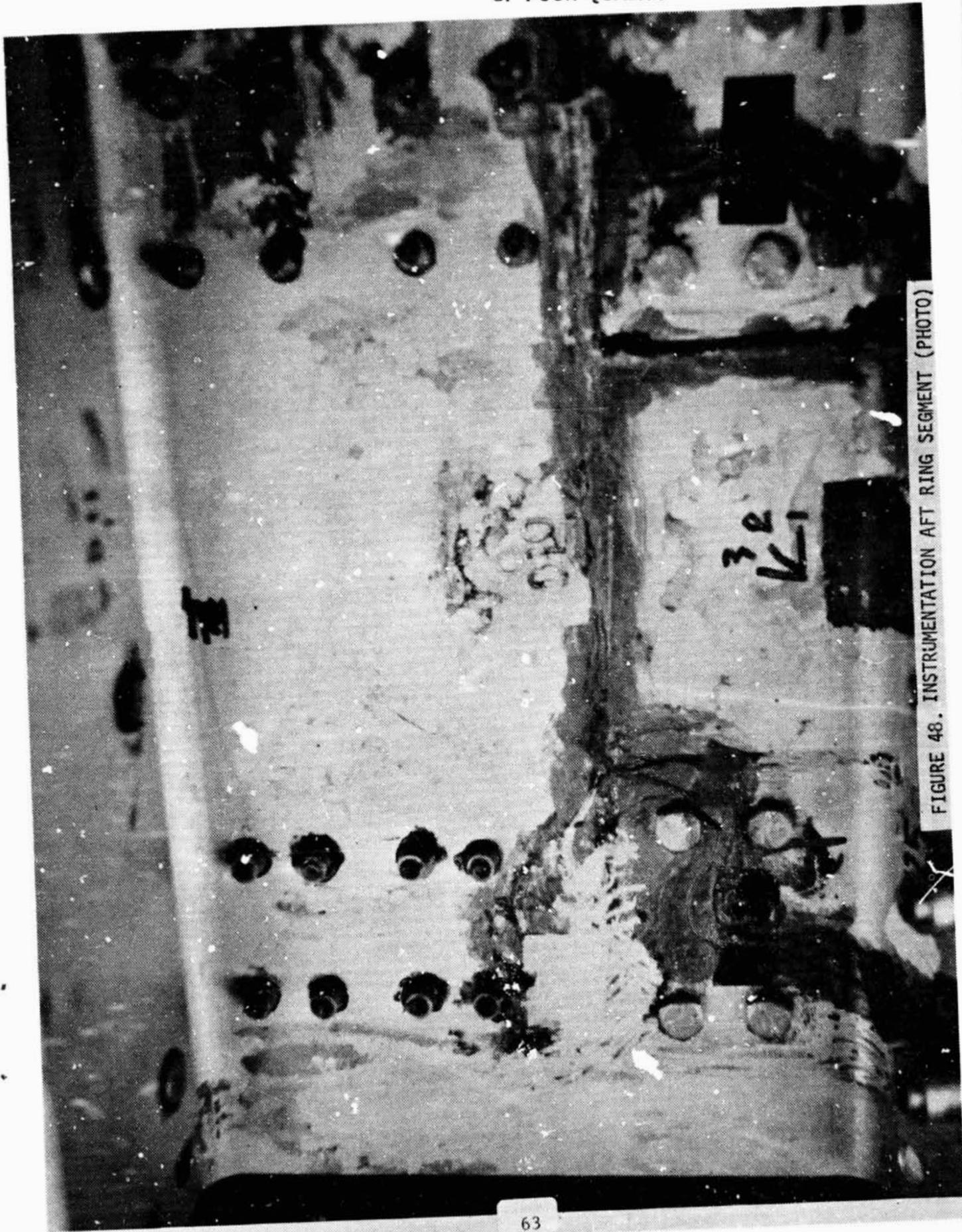


FIGURE 48. INSTRUMENTATION AFT RING SEGMENT (PHOTO)

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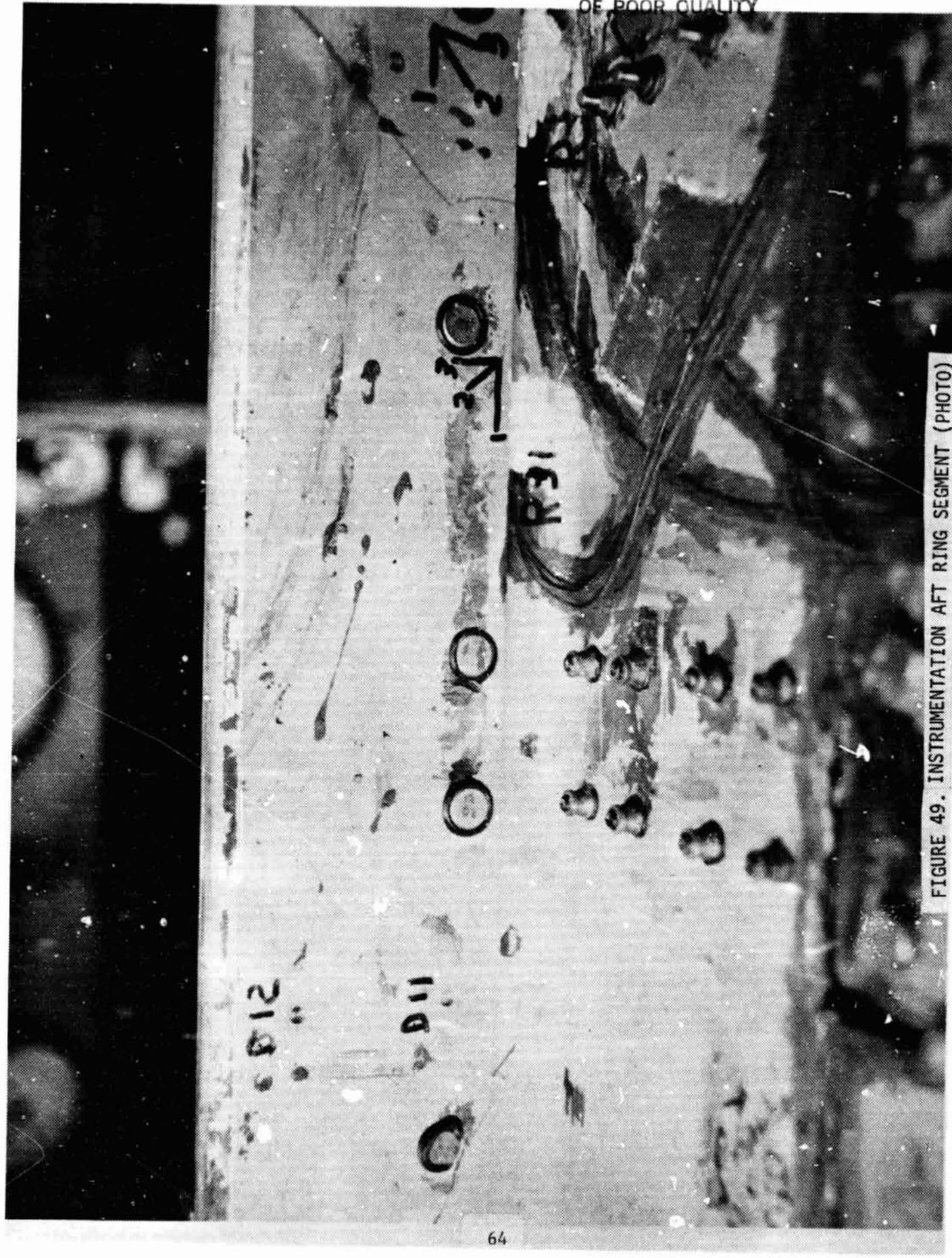


FIGURE 49. INSTRUMENTATION AFT RING SEGMENT (PHOTO)

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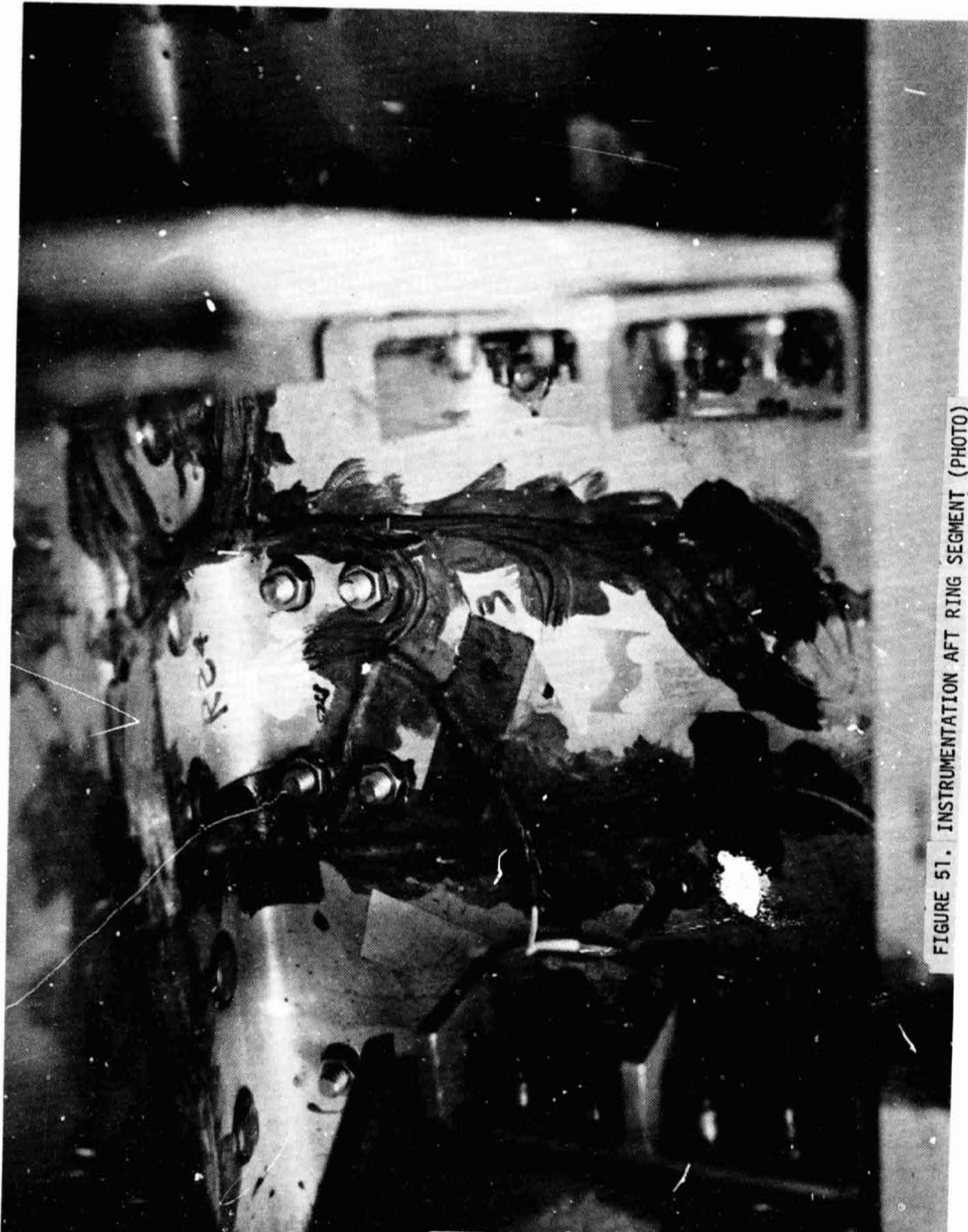


FIGURE 51. INSTRUMENTATION AFT RING SEGMENT (PHOTO)

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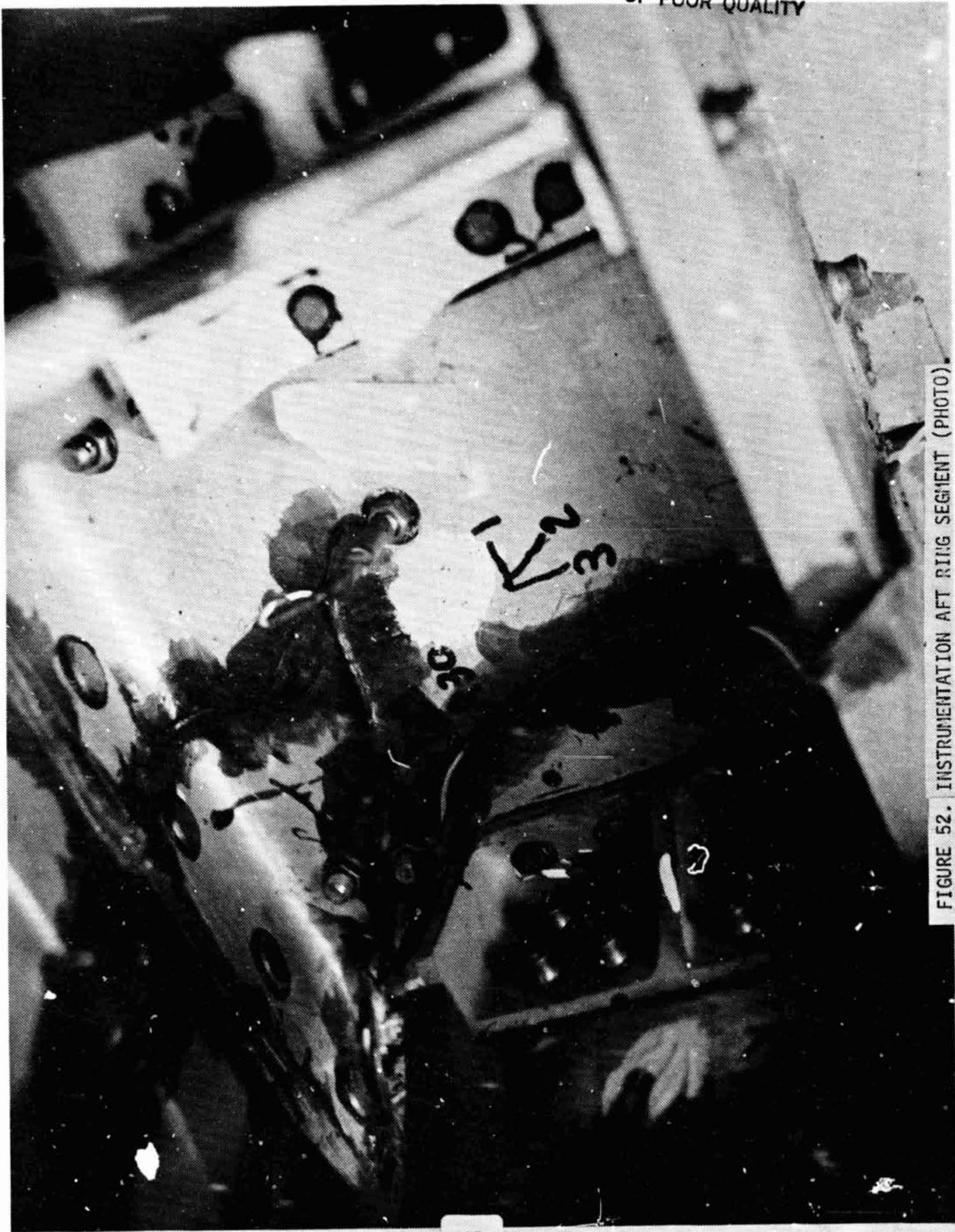


FIGURE 52. INSTRUMENTATION AFT RING SEGMENT (PHOTO)



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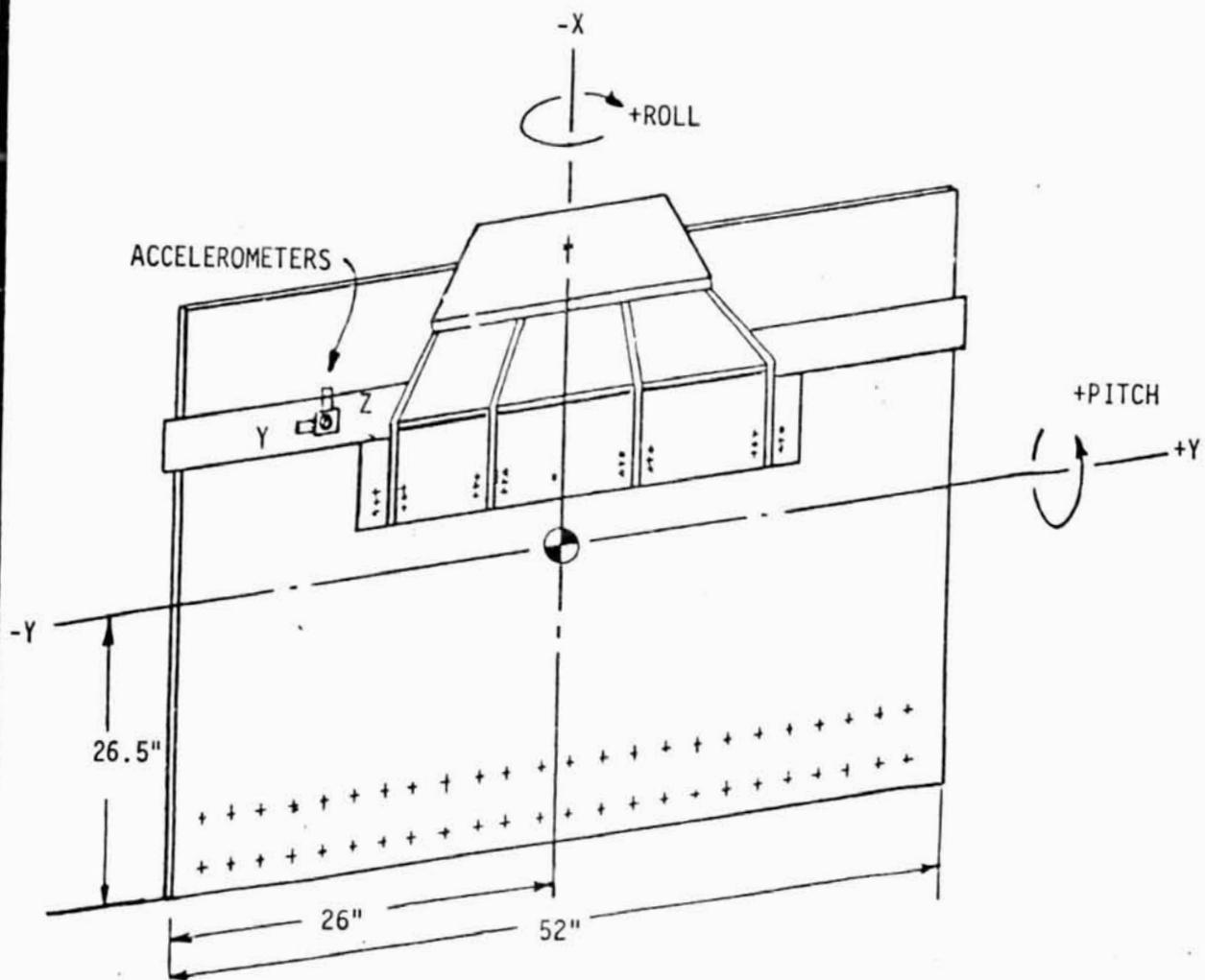


FIGURE 53 - BALANCE SIGN CONVENTION

Inst. I. D.	Type Meas.	Location	Remarks*
E11	PCB Model H302 A04 Quartz	Axial at Rod/Model Interface Plate	All Runs
EP2	Accelerometer	Pitch	
EY3		Yaw	
M01	PCB Piezotronics	Inner Flg. Between Ribs 2 and 3	
M02	High Freq. Model H113 A22	Web	
M03	Pressure Transducer	Outer Flg.	
M04		Skin	
M05			
M06			
M07			Inner Flg. Between Ribs 2D and 3D
M08		Web	
M09		Outer Flg.	
M10		Skin	
M11		Skin	
M12		Skin	All Runs

TABLE II - INSTRUMENTATION - MID RING SEGMENT

Inst. I. D.	Type Meas.	Location	Remarks*
U1001	BLH Uniaxial; Constantan Foil Strain Gage	Test fixture Gusset, rib 3	Data Recorded 10 thru 12 only A11 Runs
U1002			Data Recorded 10 thru 12 only A11 Runs
U1003			Data Recorded 10 thru 12 only A11 Runs
U1004			A11 Runs
U1005		Test fixture Gusset, rib 1D	A11 Runs
U1006			Data Recorded on Runs 10 thru 12 only A11 Runs
U1007			A11 Runs
U1008			Data Recorded 10 thru 12 only ORIGIN OF POOR PAGE QUALITY
U1009			↓
U1010			↓
U1011		Test fixture aft rib 4D	No Data Recorded
U1012			Data Recorded 10 thru 12 only
U1013			↓
U1014		Test fixture Gusset, rib 4D	A11 Runs
U1015			Data on Run 24 only
U1016			Data on Runs 10 thru 12 only 27-30, 33, 35, 37, 38, 40, 46
U1017	Inboard clip, rib 1	rib 2	A11 Runs
U1018			

TABLE II. - INSTRUMENTATION - MID RING SEGMENT
(Continued)

Inst. I. D.	Type Meas.	Location	Remarks*
U1019	BLH Uniaxial Constantan Foil Strain Gage	Inboard clip, rib 3	All Runs
U1020		rib 4	Data Recorded on Runs 13, 14, 16, 17, 18 19, 24, 27-30, 33, 35, 37, 38, 40, 46
U1021		Outboard clip, rib 1	Data Recorded on Runs 13, 14, 16, 17, 18 19, 24, 27-30, 35, 37, 38, 40, 46
U1022		rib 2	
U1023		rib 3	No Data Run 24-only
U1024		rib 4	Data Recorded on Runs 13, 14, 16, 17, 18 19, 24, 27, 30, 35, 37, 38, 40-46
U1025		Forward, rib 4	All Runs
U1026		Skin between ribs 2 and 3	
U1027		Gusset, rib 4	
U1028		Aft, rib 4	
U1029		Fwd. rib 3	
U1030		Gusset, rib 3	ORIGINAL PAGE OF POOR QUALITY
U1031			
U1032		Aft, rib 3	
U1033			
U1034		Fwd. rib 2	
U1035		Gusset, rib 2	
U1036			

TABLE II - INSTRUMENTATION - MID RING SEGMENT
(Continued)

Inst. I. D.	Type Meas.	Location	Remarks*
U1037	BLH Uniaxial Constantan Front Strain Gage	Aft, rib 2	All Runs
U1038		↓	
U1039		Fwd. rib 1	→
U1040		Skin between ribs 1D and 2D	
U1041		Gusset, rib 1	
U1042		Aft. rib 1	Data Recorded on Runs 13, 14, 16, 17, 18, 19, 24, 27-30, 33, 35, 37, 38, 40, 46 only
U1043		Fwd. rib 1D	→
U1044		Gusset, rib 1D	No data recorded
U1045		Aft, rib 1D	
U1046		Fwd. rib 2D	All Runs
U1047		Gusset, rib 2D	Data Recorded on Runs 13, 14, 16, 17, 18, 19, 24, 27-30, 33, 35, 37, 38, 40, 46 only
U1048		Aft, rib 2D	All Runs
U1049		↓	ORIGINAL PAGE IS OF POOR QUALITY
U1050		Fwd. rib 3D	
U1051		Gusset, rib 3D	
U1052		Aft, rib 3D	
U1053		↓	
U1054		Fwd. rib 4D	→

TABLE II - INSTRUMENTATION - MID RING SEGMENT
(Continued)

Inst. I. D.	Type Meas.	Location	Remarks*
R301-1	BLH Rosette Constantan Foil Strain Gage	Upper rib 1D	Data Recorded on Runs 18, 19, 24, 27-30, 33, 35, 37, 38, 40, 46 only
2			
3			
R302-1			ORIGINAL PAGE OF POOR QUALITY
2		1	
3			
R303-1		2D	No Data Recorded
2			
3			
R304-1		2	Data Recorded on Runs 13, 14, 16-19, 24 27-30, 33, 35, 37, 38, 40, 46 only
2			
3			
R305-1		Gusset, rib 1	Data Recorded on Runs 13, 14, 16-19, 24 27-30, 33, 35, 37, 38, 40, 46 only
2			
3			
R306-1		Test fixture	Data on Runs 10-12 only
2			
3			

TABLE II - INSTRUMENTATION - MID RING SEGMENT
(Continued)

Inst. I. D.	Type Meas.	Location	Remarks*
R307-1	BLH Rosette Constantan Foil Strain Gage	Test fixture	All Runs
2			
3			
R308-1		Gusset, rib 2	
2			
3			
R309-1			
2			
3			
R310-1		Inner flange between ribs 1 and 2	
2			
3			
R311-1			2 and 3
2			
3			
R312-1			3 and 4
2			
3			

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TABLE II - INSTRUMENTATION - MID RING SEGMENT
(Continued)

Inst. I. D.	Type Meas.	Location	Remarks*
R313-1	BLH Rosette Constantan Foil Strain Gage	Outer flange between ribs 3 and 4	All Runs
2			
3			
R314-1		2 and 3	
2			
3			
R315-1		1 and 2	
2			
3			
R316-1		1D and 2D	
2			
3			
R317-1		2D and 3D	
2			
3			
R318-1		3D and 4D	
2			
3			

TABLE II - INSTRUMENTATION - MID RIB SEGMENT
(Continued)

Inst. I. D.	Type Meas.	Location	Remarks*		
			All Runs		
R319-1	BLH Rosette Constantan Foil Strain Gage	Inner flange between ribs 3D and 4D			
2			→		
3					
R320-1			2D and 3D		
2			→		
3					
R321-1			1D and 2D		
2			→		
3					
R322-1		Web between ribs 1 and 2			
2			→		
3					
R323-1			2 and 3		
2			→		
3					
R324-1					
2			→		
3					

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(Continued)

Inst. I. D.	Type Meas.	Location	Remarks*
R32b-1	BLH Constantan Foil Strain Gage	Web between ribs 2 and 3	A11 Runs
2			
3			
R326-1		3 and 4	
2			
3			
R327-1		2D and 3D	
2			
3			
R328-1			
2			
3			
S41	BLH Uniaxial Constantan Foil Strain Gage	Axial Barrel Rod Adapter	Data Recorded 10-14, 16 & 17 only
S42		Pitch	
S43		Yaw	

TABLE II - INSTRUMENTATION - MID RING SEGMENT
(Concluded)

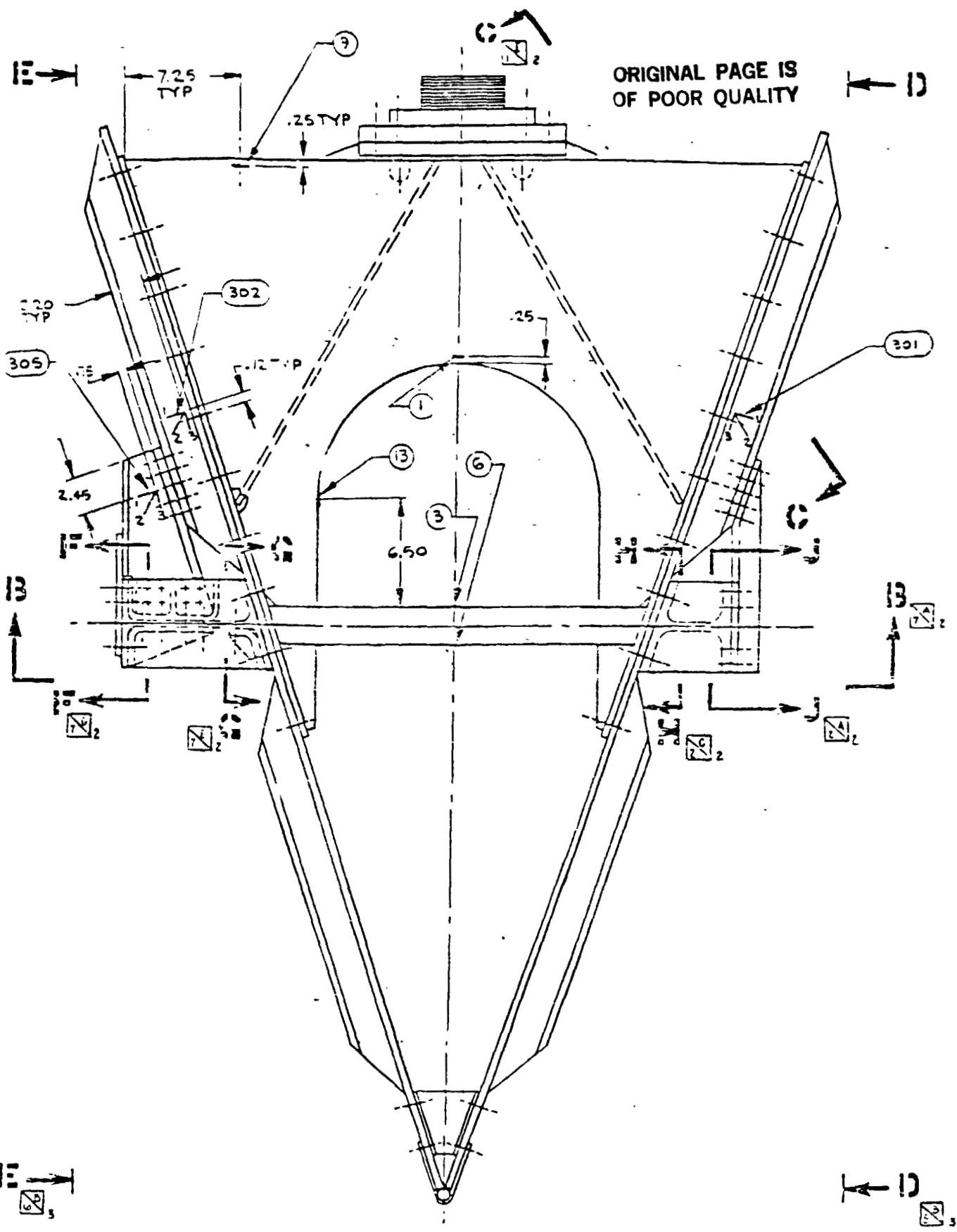
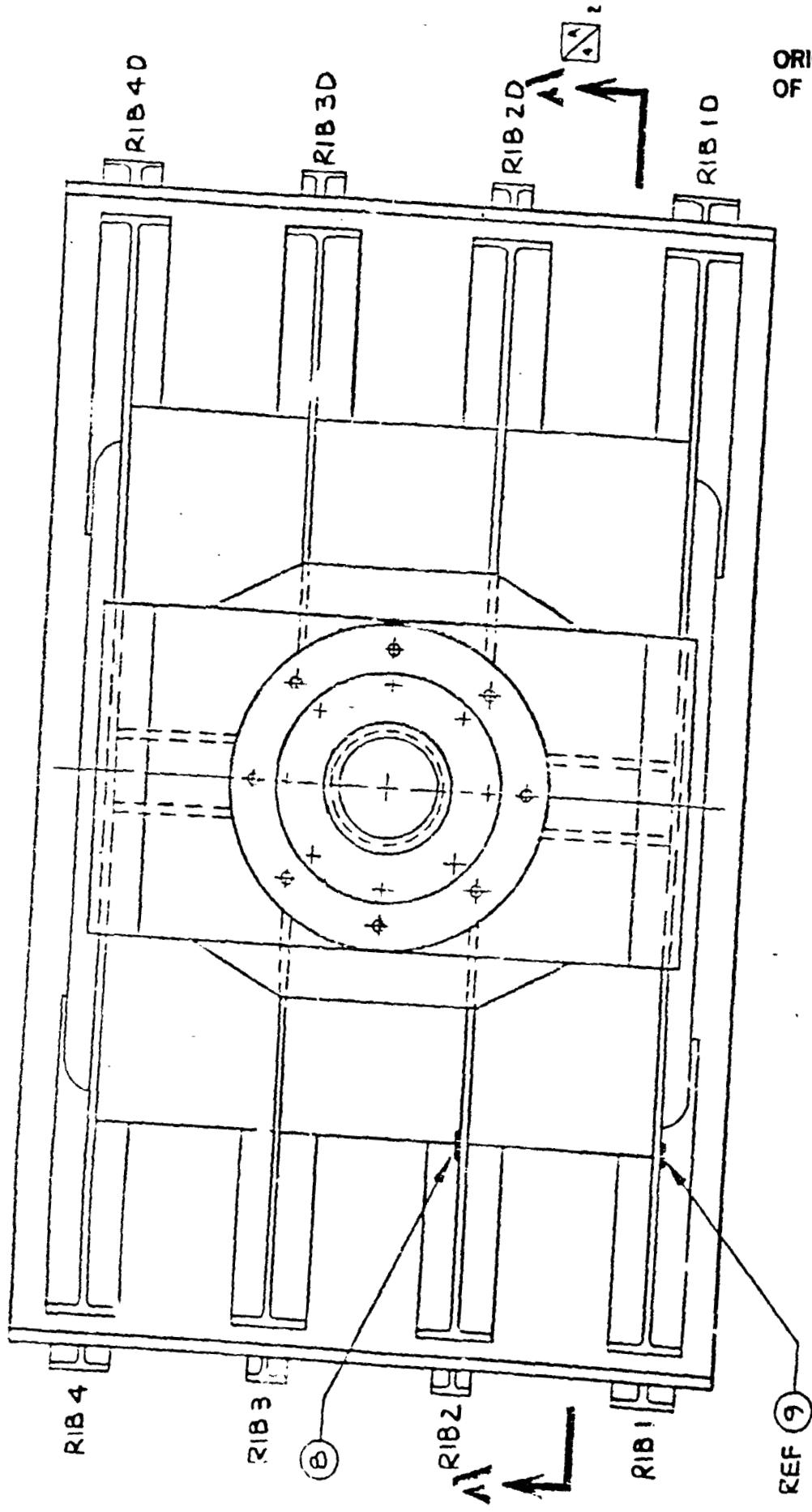


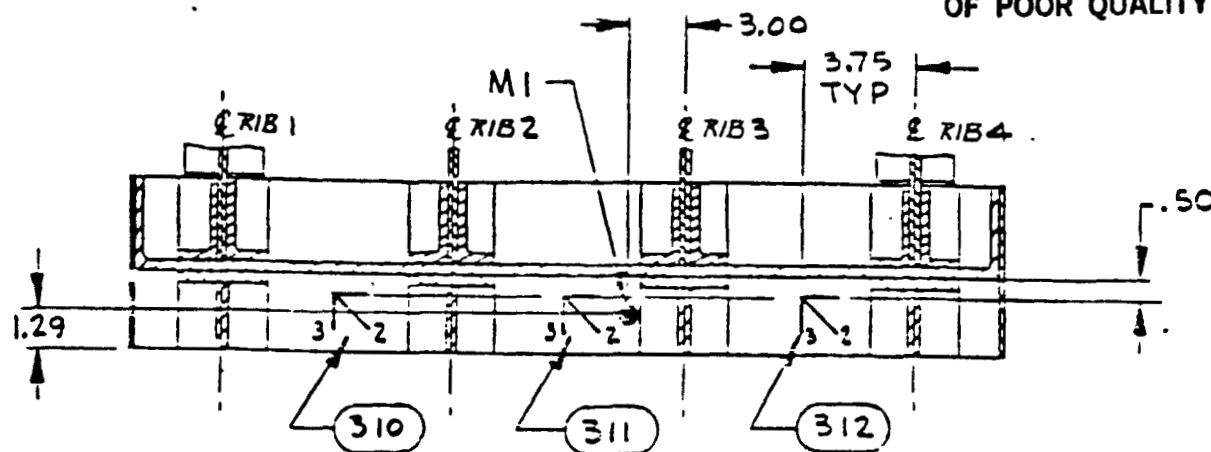
Figure 54. IID RING TEST ARTICLE INSTRUMENTATION LOCATIONS



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Figure 55 - MID RING TEST ARTICLE INSTRUMENTATION LOCATIONS

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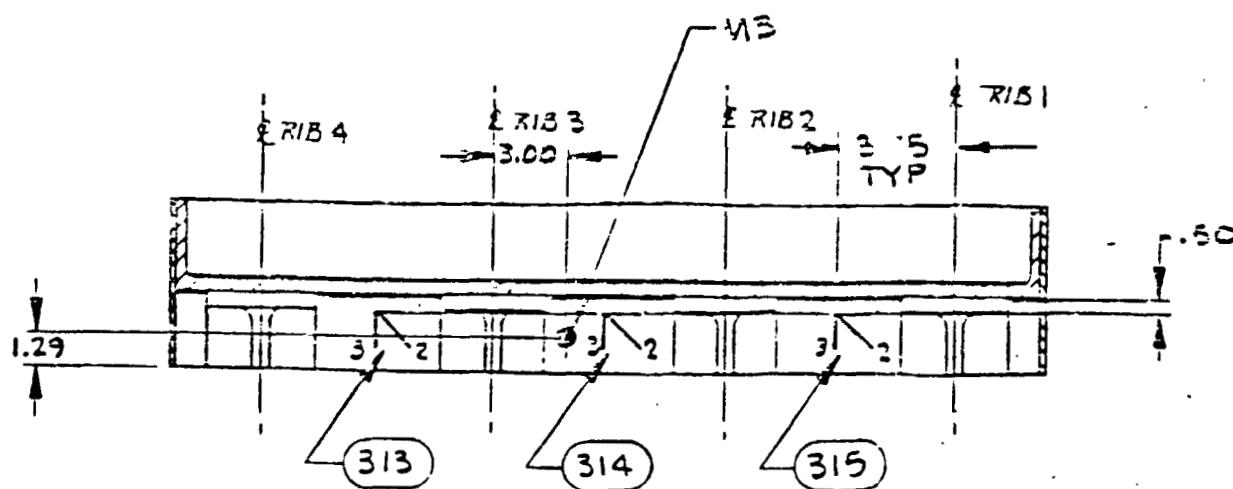


Figure 56 - MID RING TEST ARTICLE INSTRUMENTATION LOCATIONS

SECTION 6 - 6
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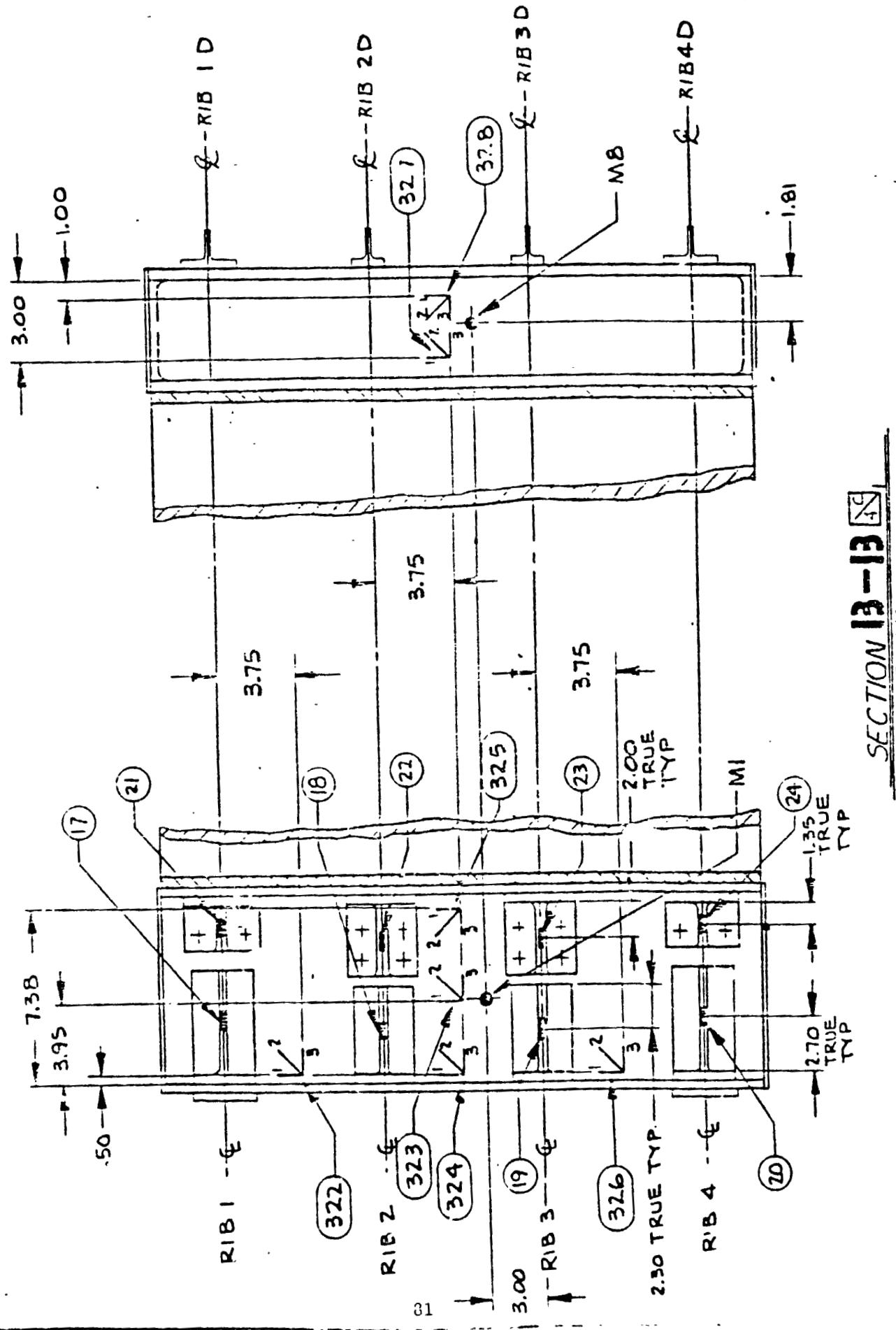
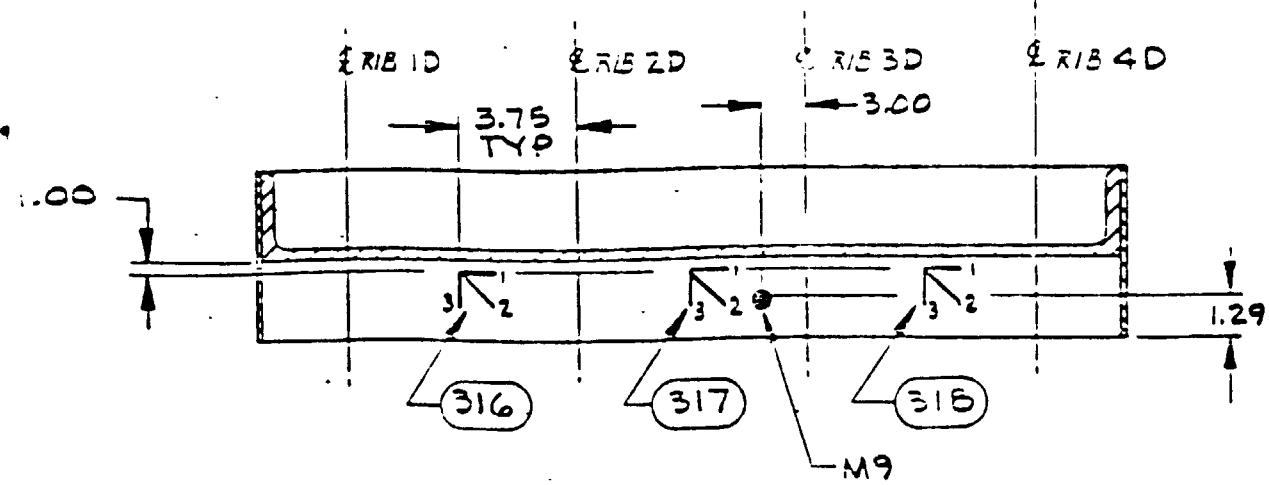
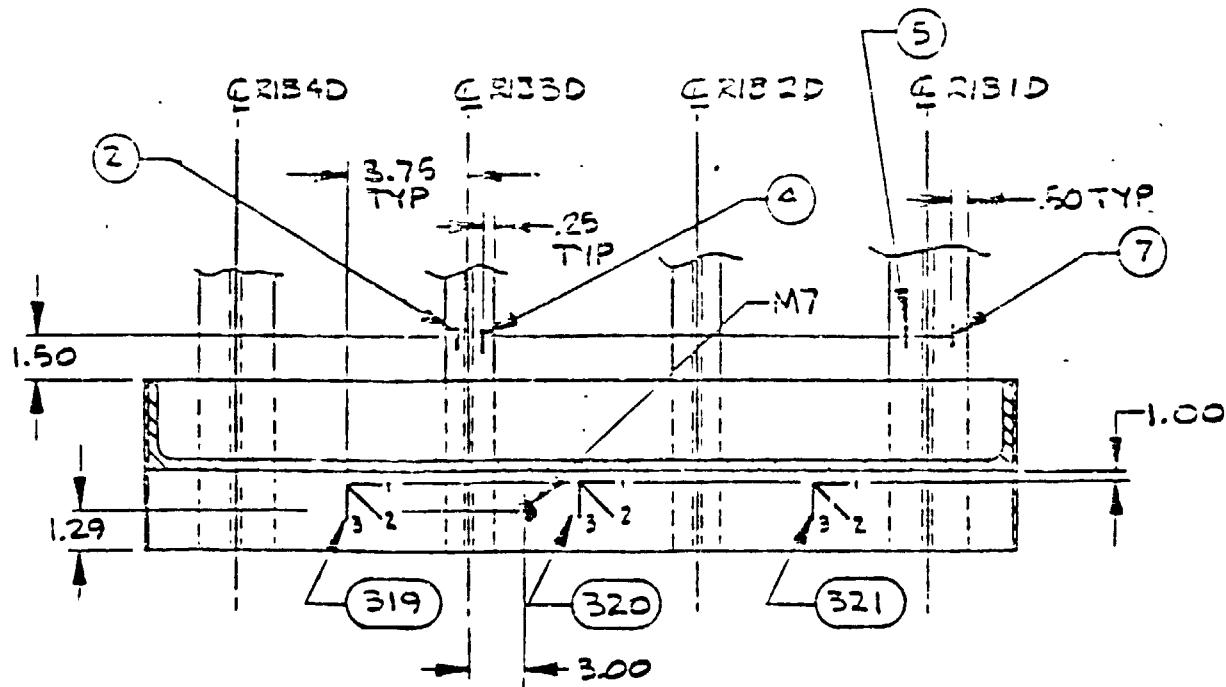


Figure 57 - MID RING TEST ARTICLE INSTRUMENTATION LOCATIONS
SCALE: $1/4$



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SECTION H-H,
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SECTION J-J,
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Figure 58 - MID RING TEST ARTICLE INSTRUMENTATION LOCATIONS

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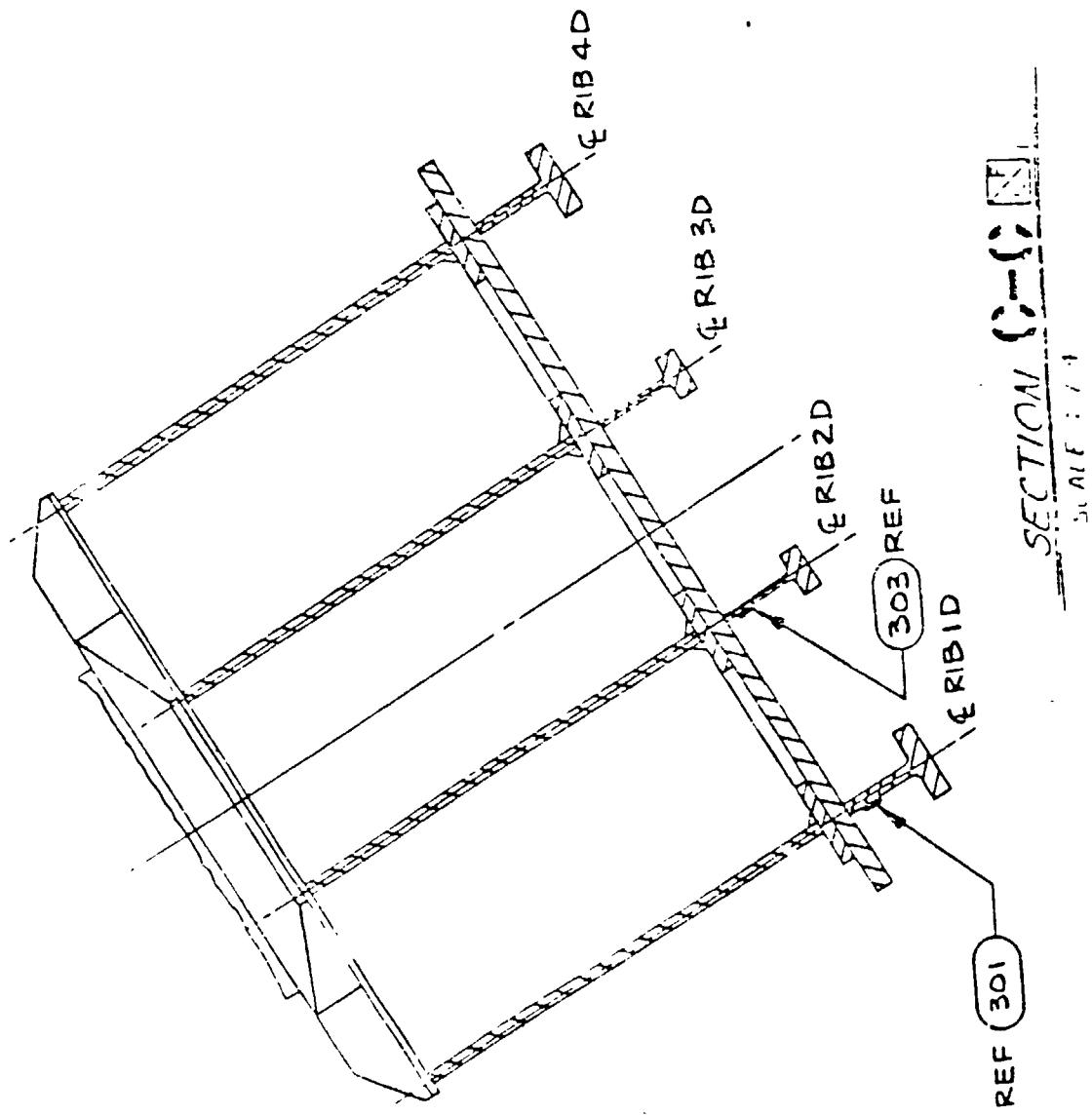
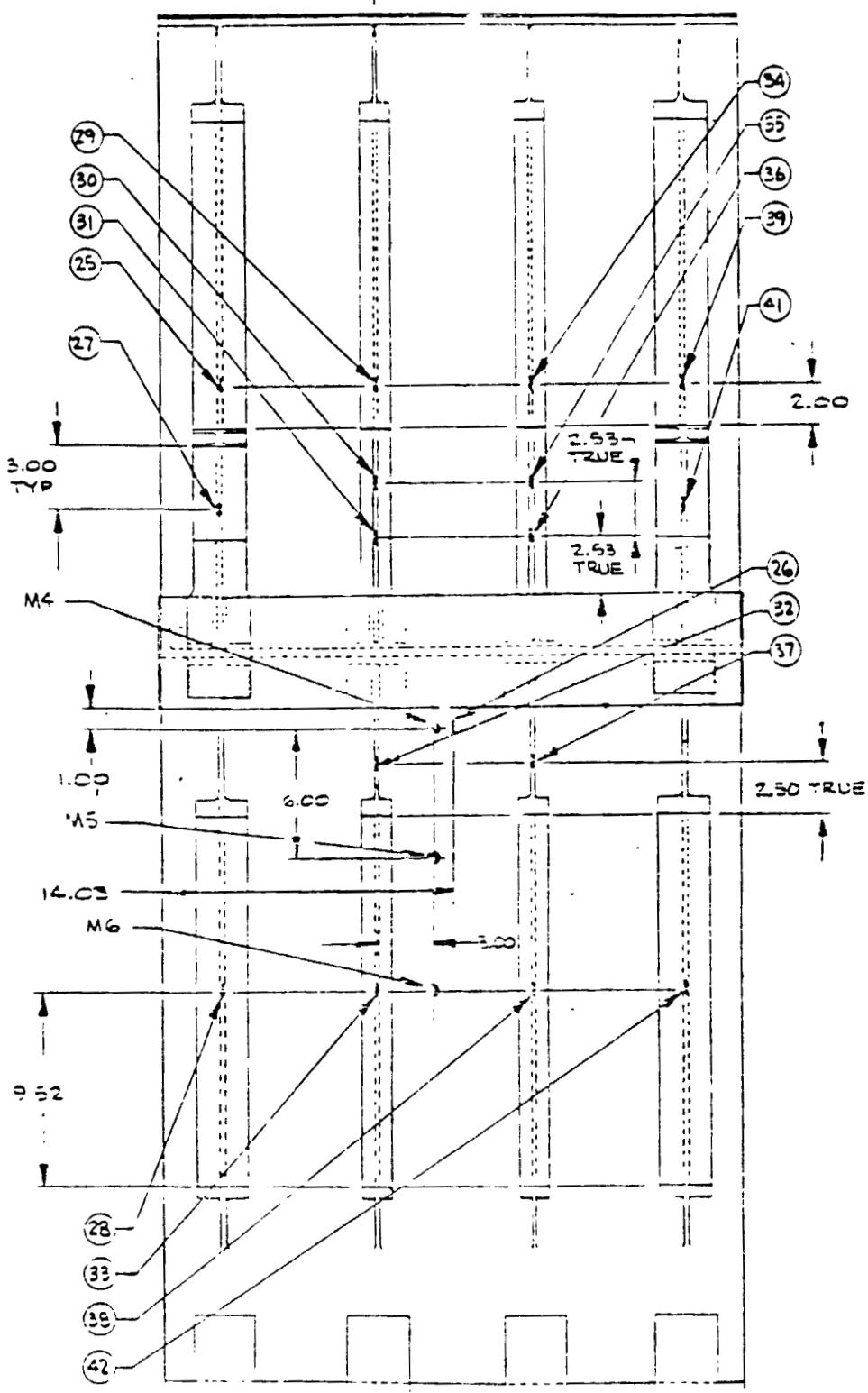


Figure 59 - MID RING TEST ARTICLE INSTRUMENTATION LOCATIONS

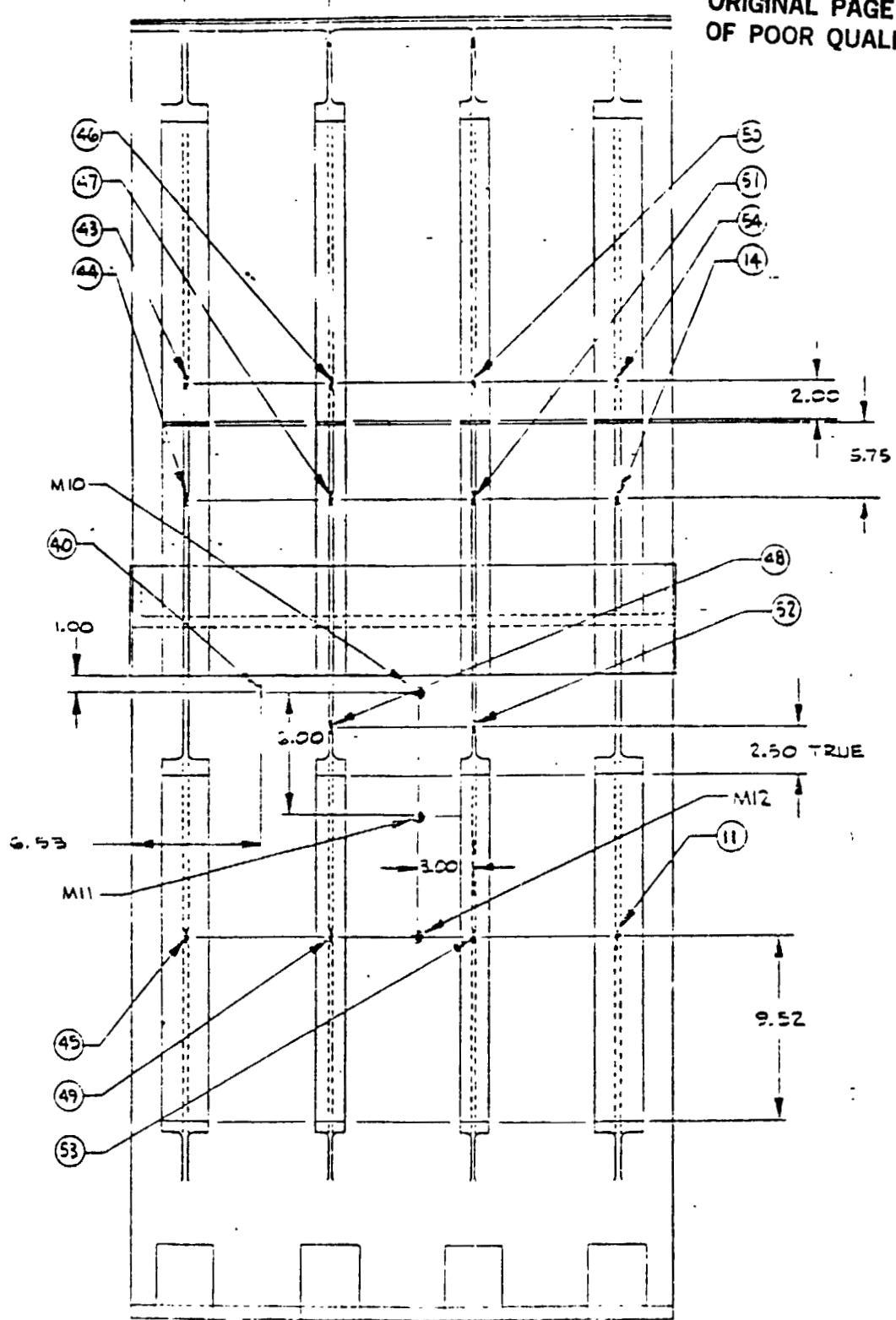
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SECTION E - E

Figure 60 - MID RING TEST ARTICLE INSTRUMENTATION LOCATIONS

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Figure 61 - MID RING TEST ARTICLE INSTRUMENTATION LOCATIONS

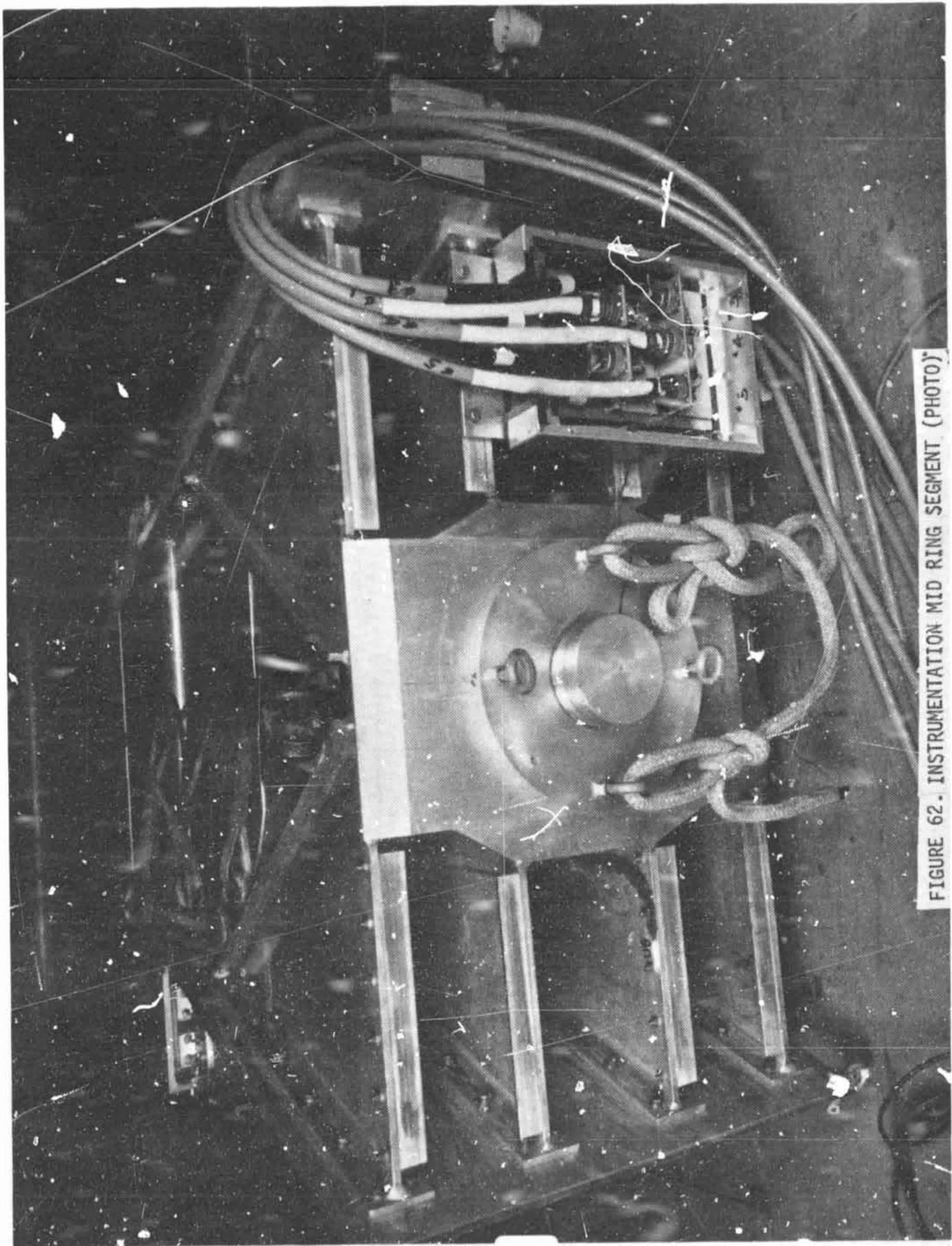


FIGURE 62. INSTRUMENTATION MID RING SEGMENT (PHOTO)*

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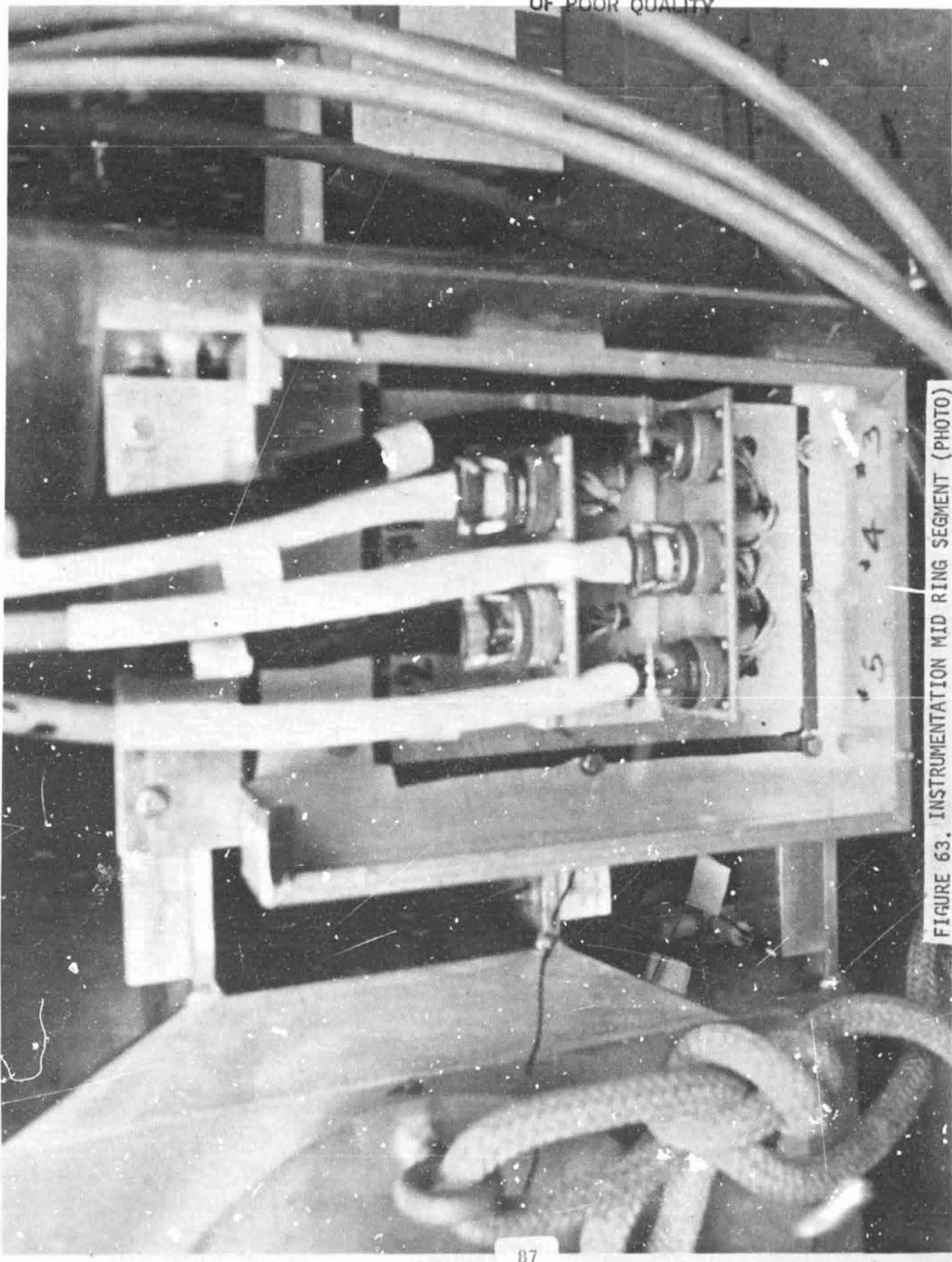


FIGURE 63. INSTRUMENTATION MID RING SEGMENT (PHOTO)

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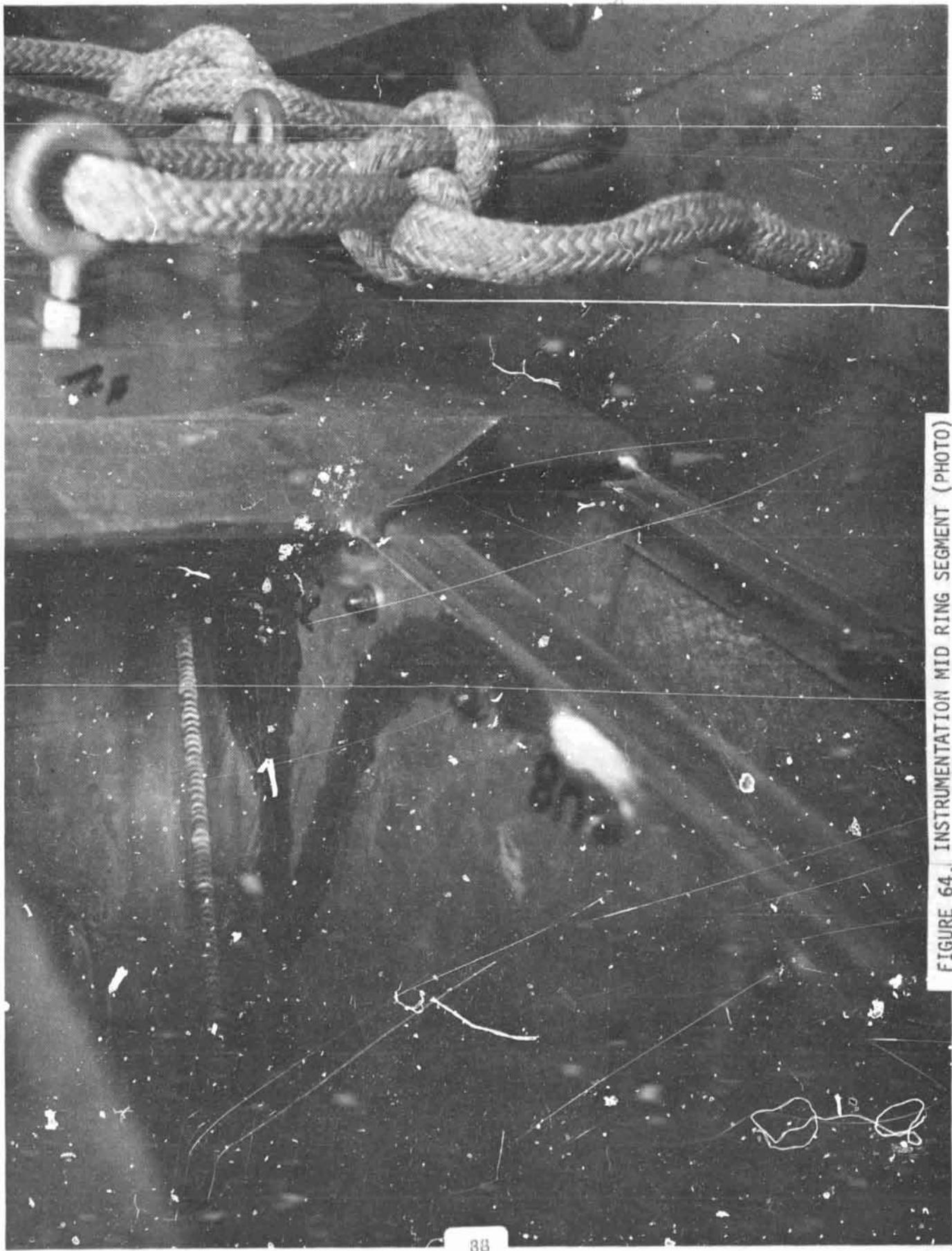


FIGURE 64. INSTRUMENTATION MID RING SEGMENT (PHOTO)

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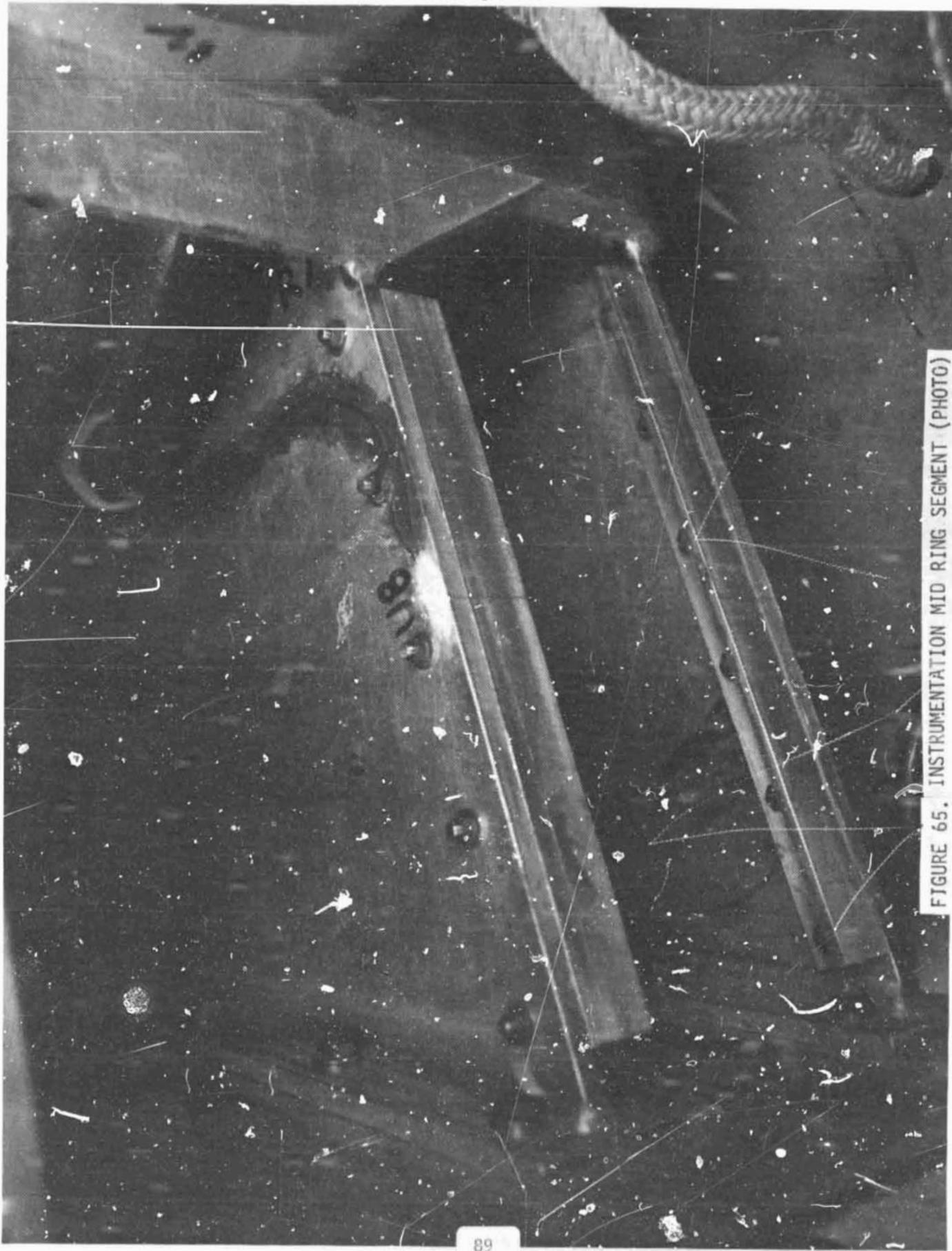


FIGURE 65. INSTRUMENTATION MID RING SEGMENT (PHOTO)

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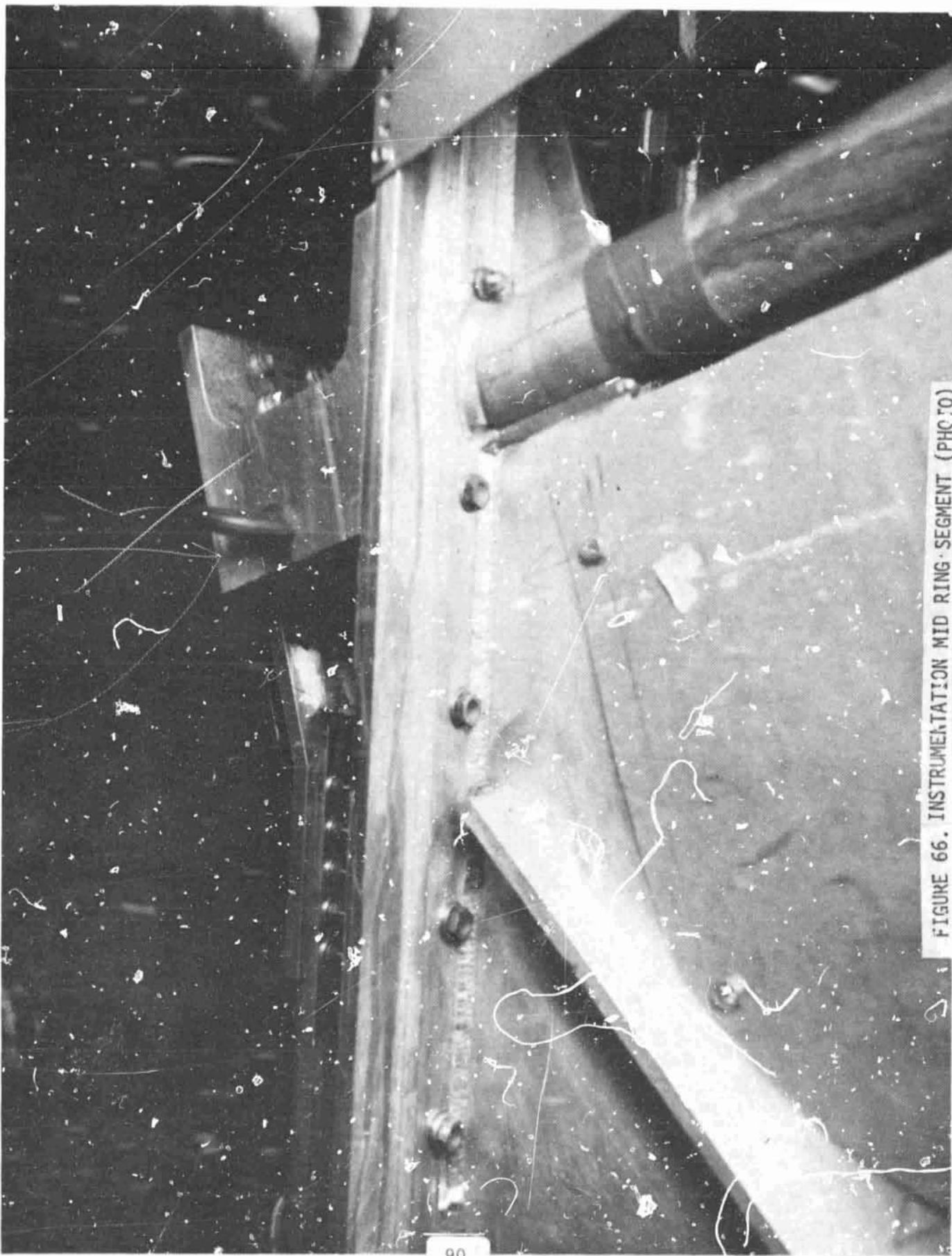


FIGURE 66. INSTRUMENTATION MID RING SEGMENT (PHOTO)

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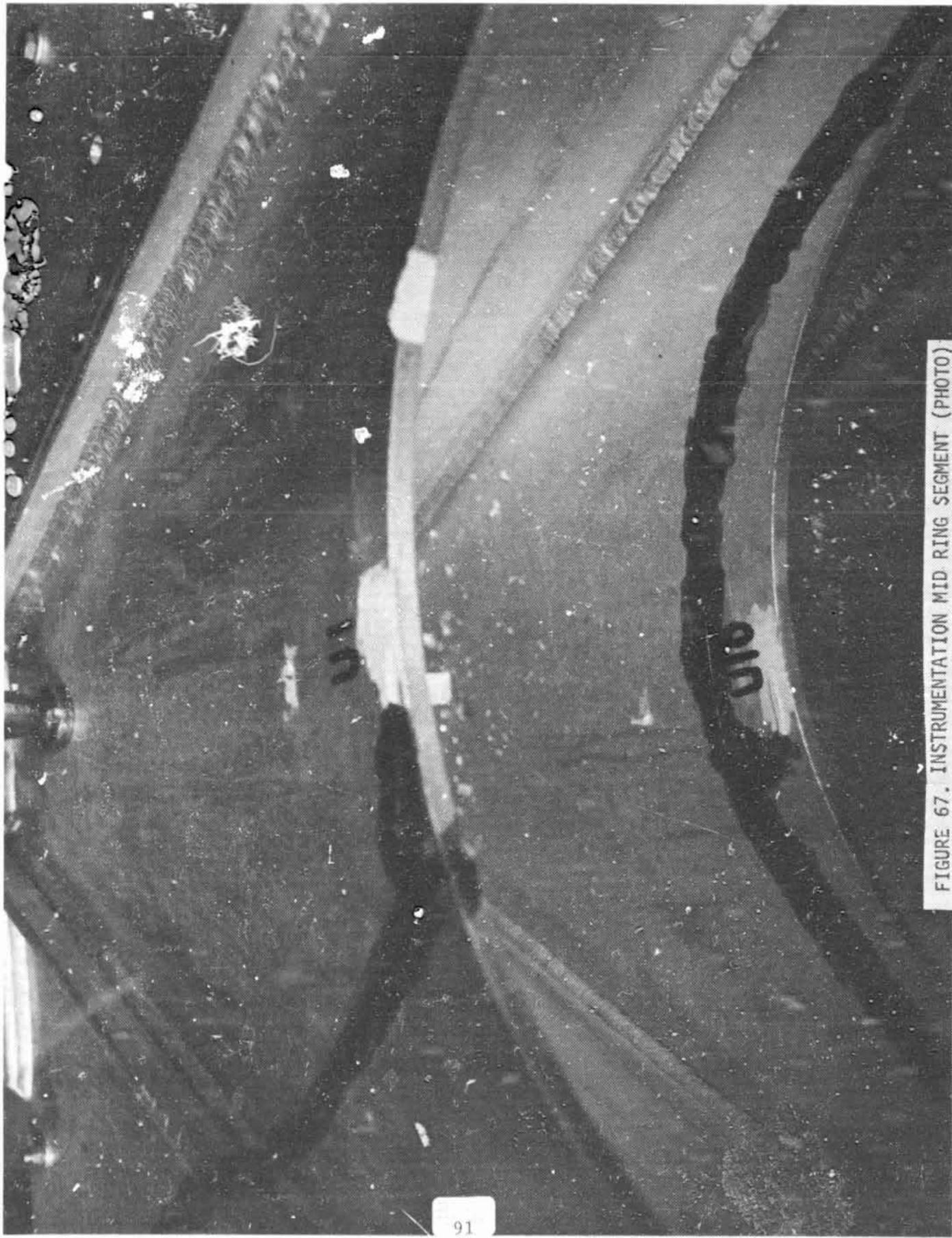


FIGURE 67. INSTRUMENTATION MID RING SEGMENT (PHOTO)

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FIGURE 68. INSTRUMENTATION MID RING SEGMENT (PHOTO)

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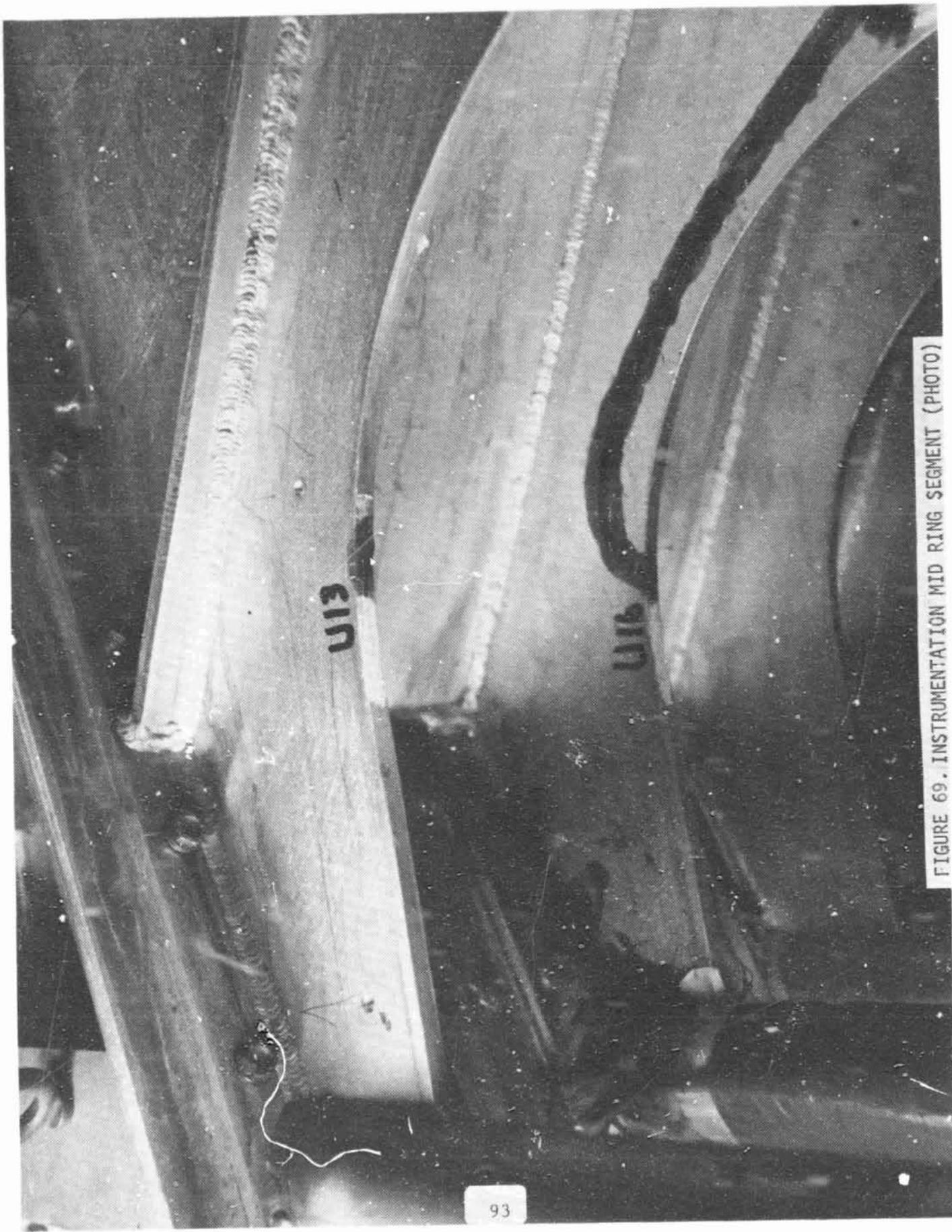


FIGURE 69. INSTRUMENTATION MID RING SEGMENT (PHOTO)

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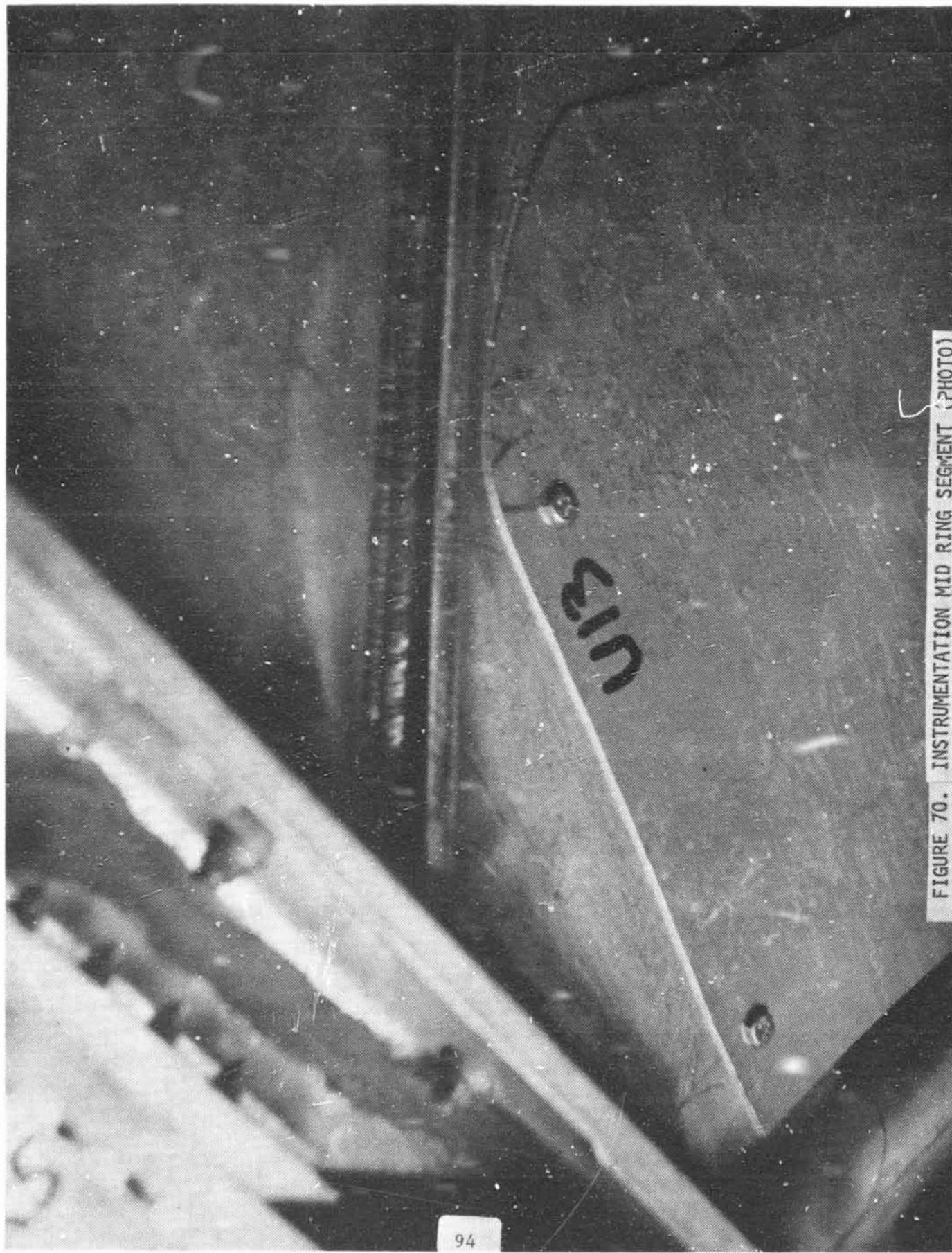


FIGURE 70. INSTRUMENTATION MID RING SEGMENT (PHOTO)

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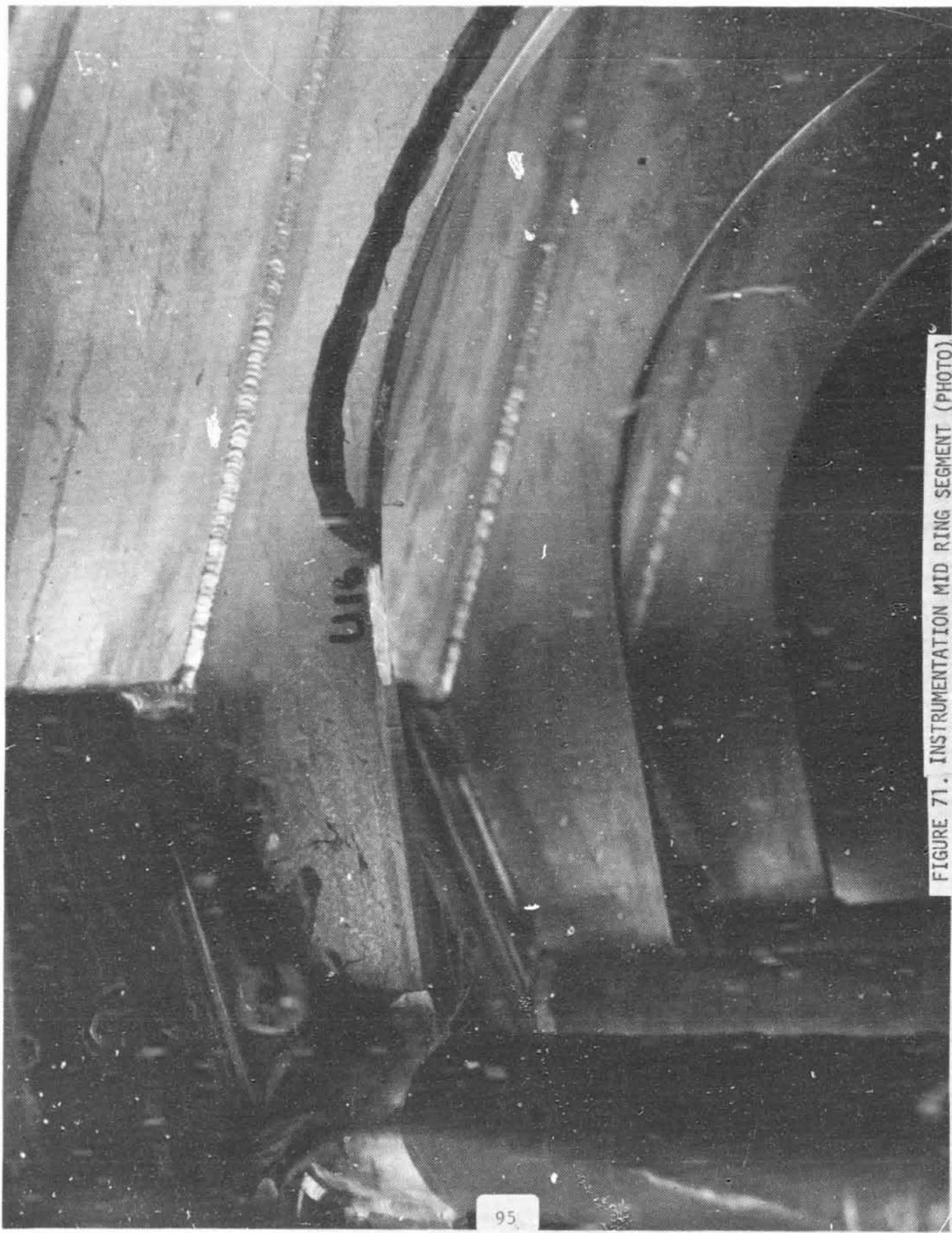


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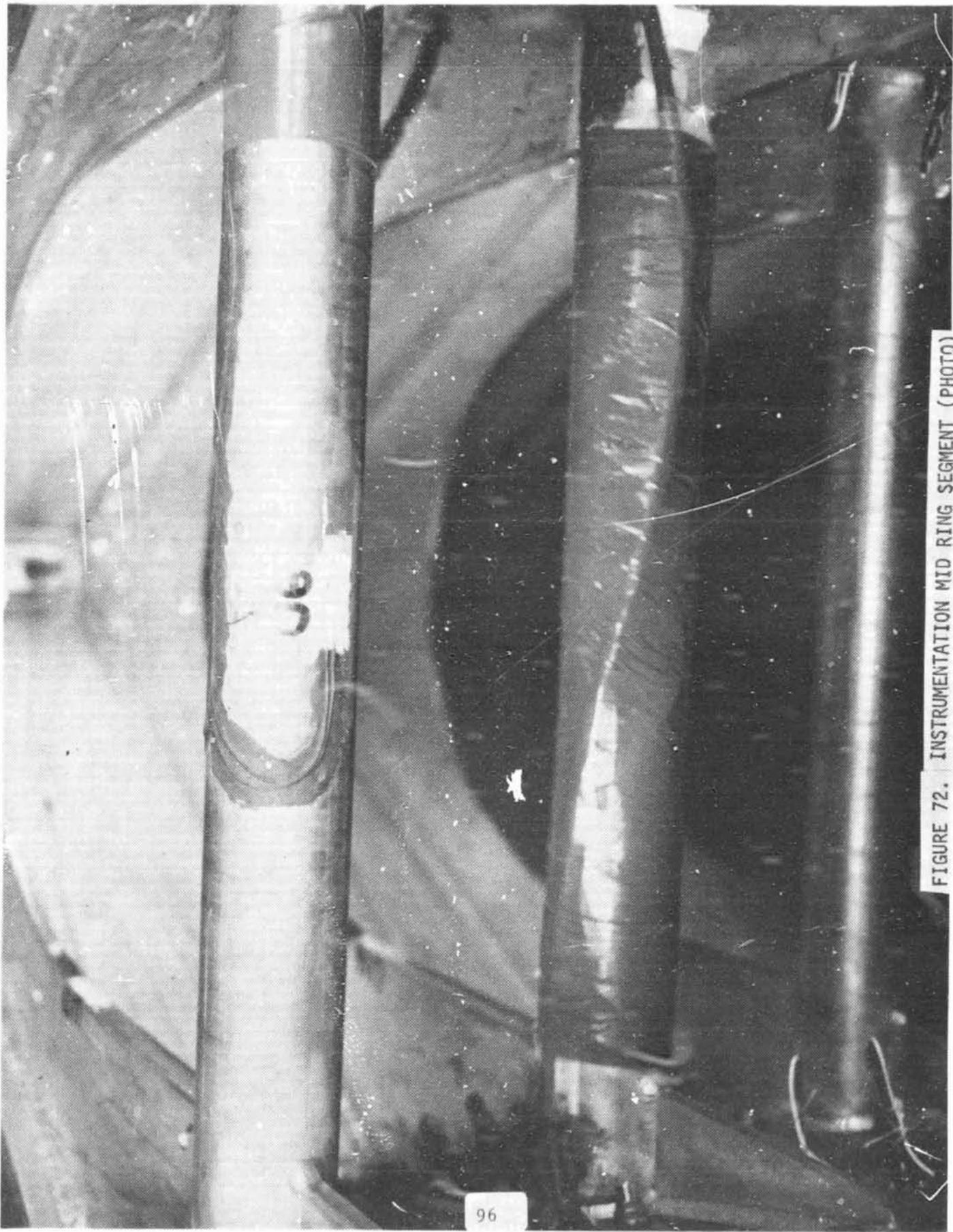


FIGURE 72. INSTRUMENTATION MID RING SEGMENT (PHOTO)

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FIGURE 73. INSTRUMENTATION MID RING SEGMENT (PHOTO)

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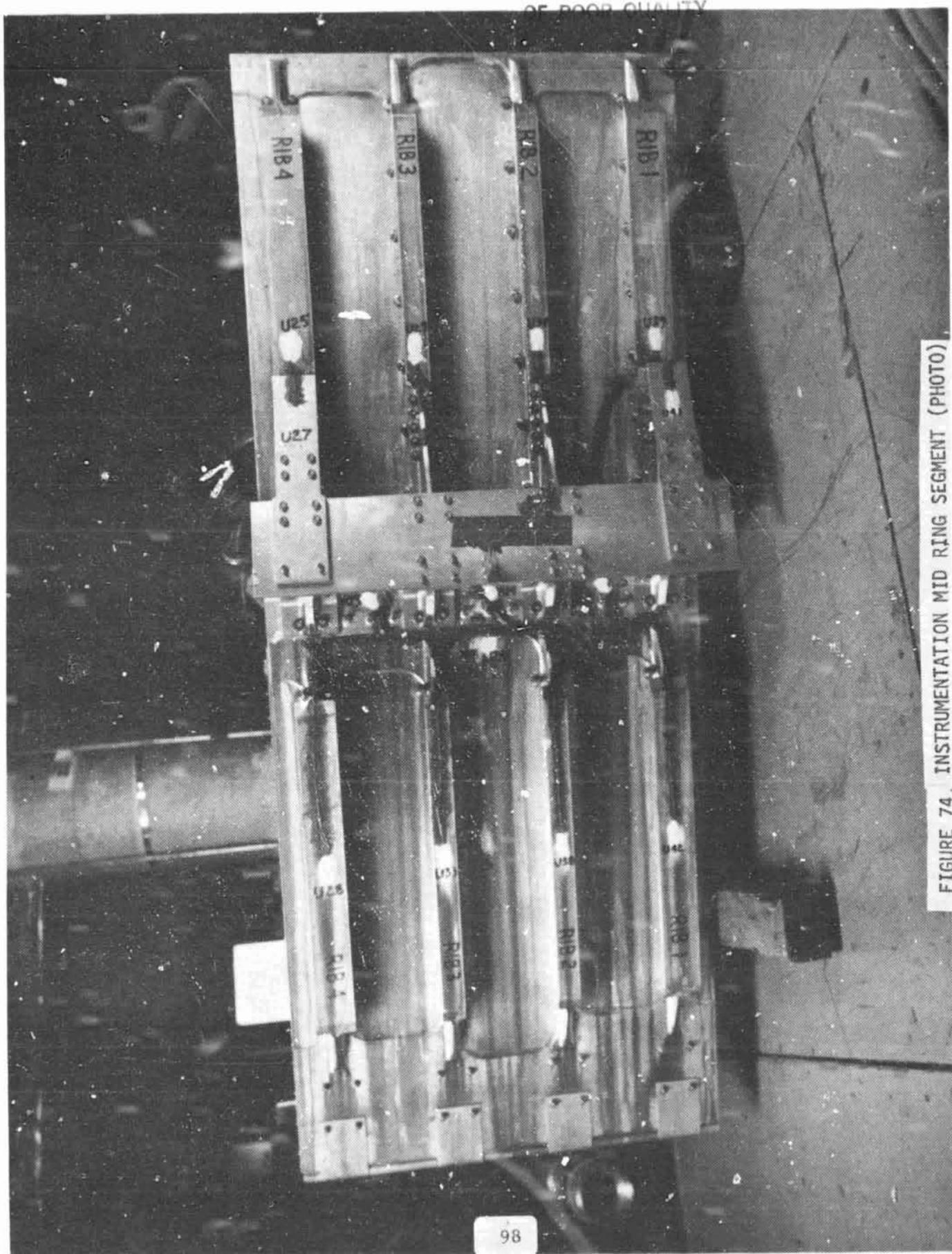


FIGURE 74. INSTRUMENTATION MID RING SEGMENT (PHOTO).

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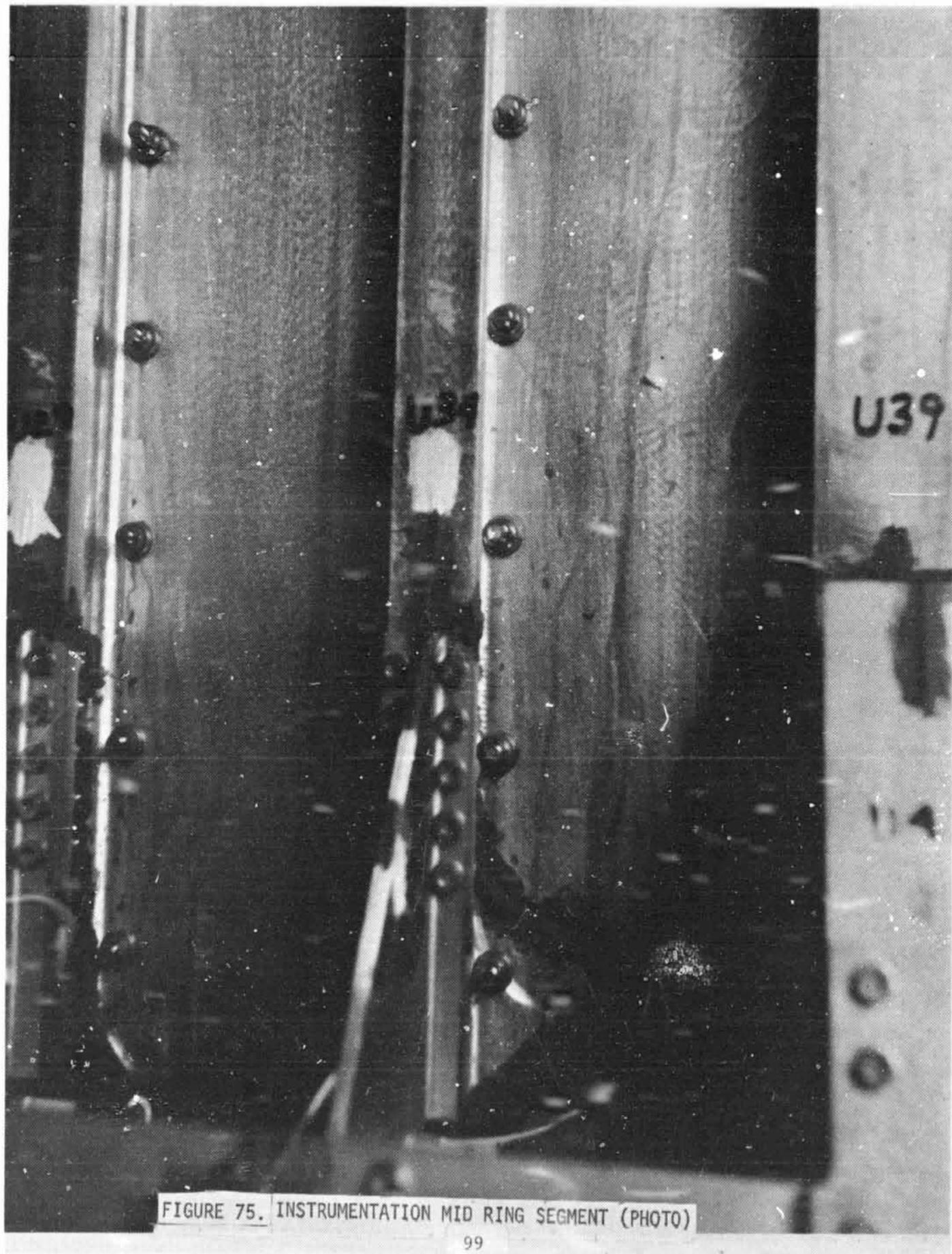


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FIGURE 76. INSTRUMENTATION MID RING SEGMENT (PHOTO)

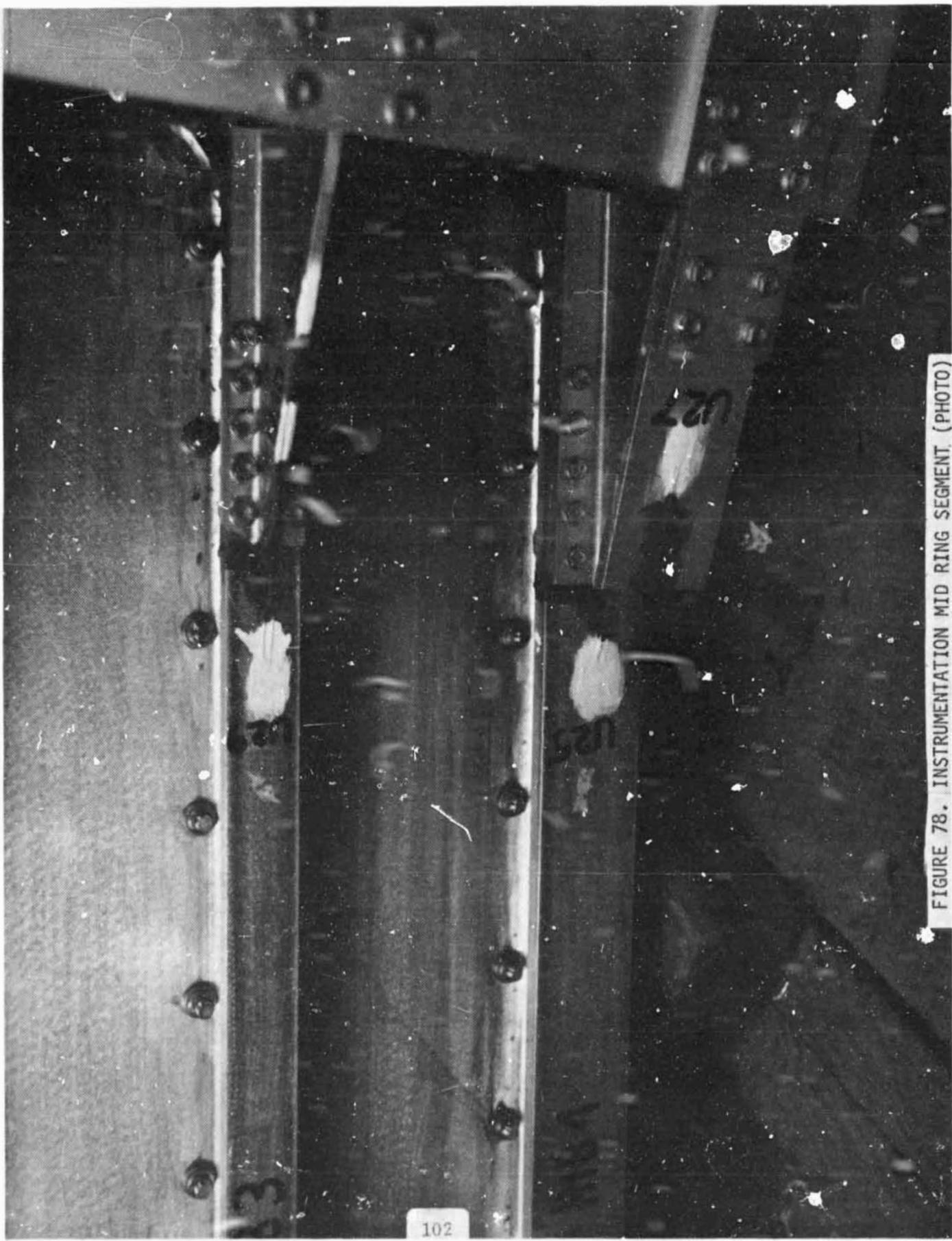
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FIGURE 77. INSTRUMENTATION MID RING SEGMENT (PHOTO)

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FIGURE 78. INSTRUMENTATION MID RING SEGMENT. (PHOTO)



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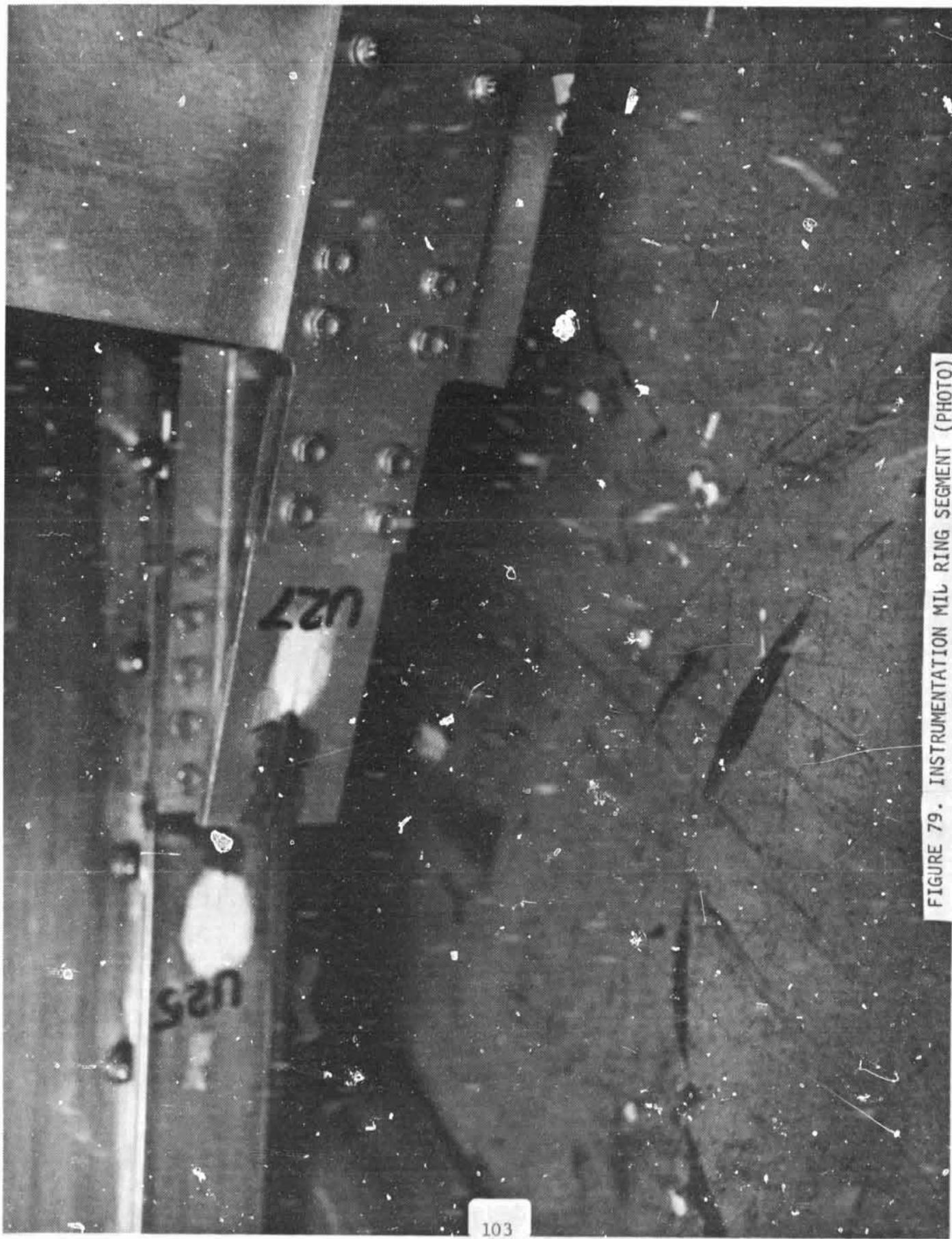


FIGURE 79. INSTRUMENTATION MIL RING SEGMENT (PHOTO)

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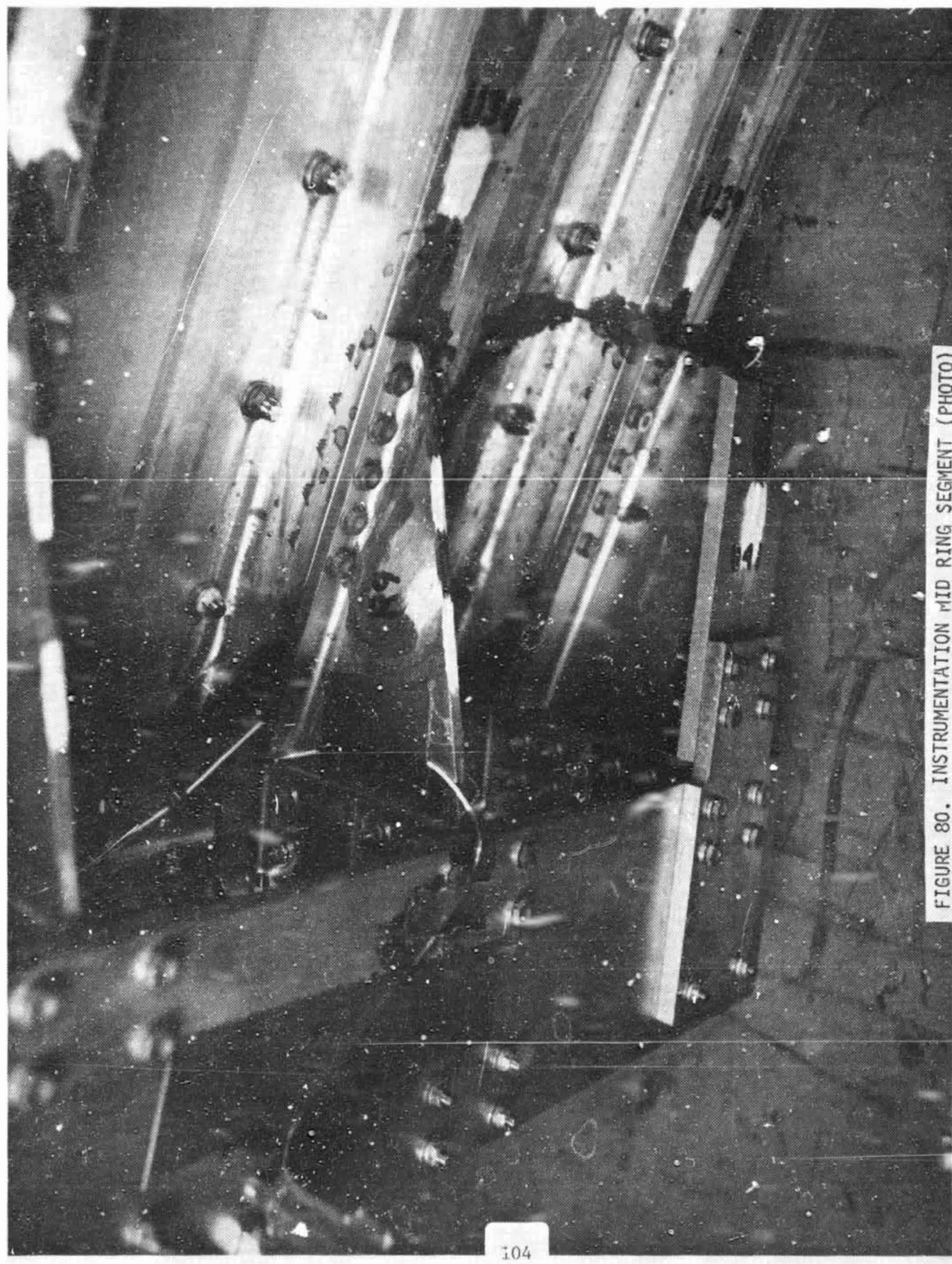


FIGURE 80. INSTRUMENTATION MID RING SEGMENT (PHOTO)

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FIGURE 81. INSTRUMENTATION MID RING SEGMENT (PHOTO)

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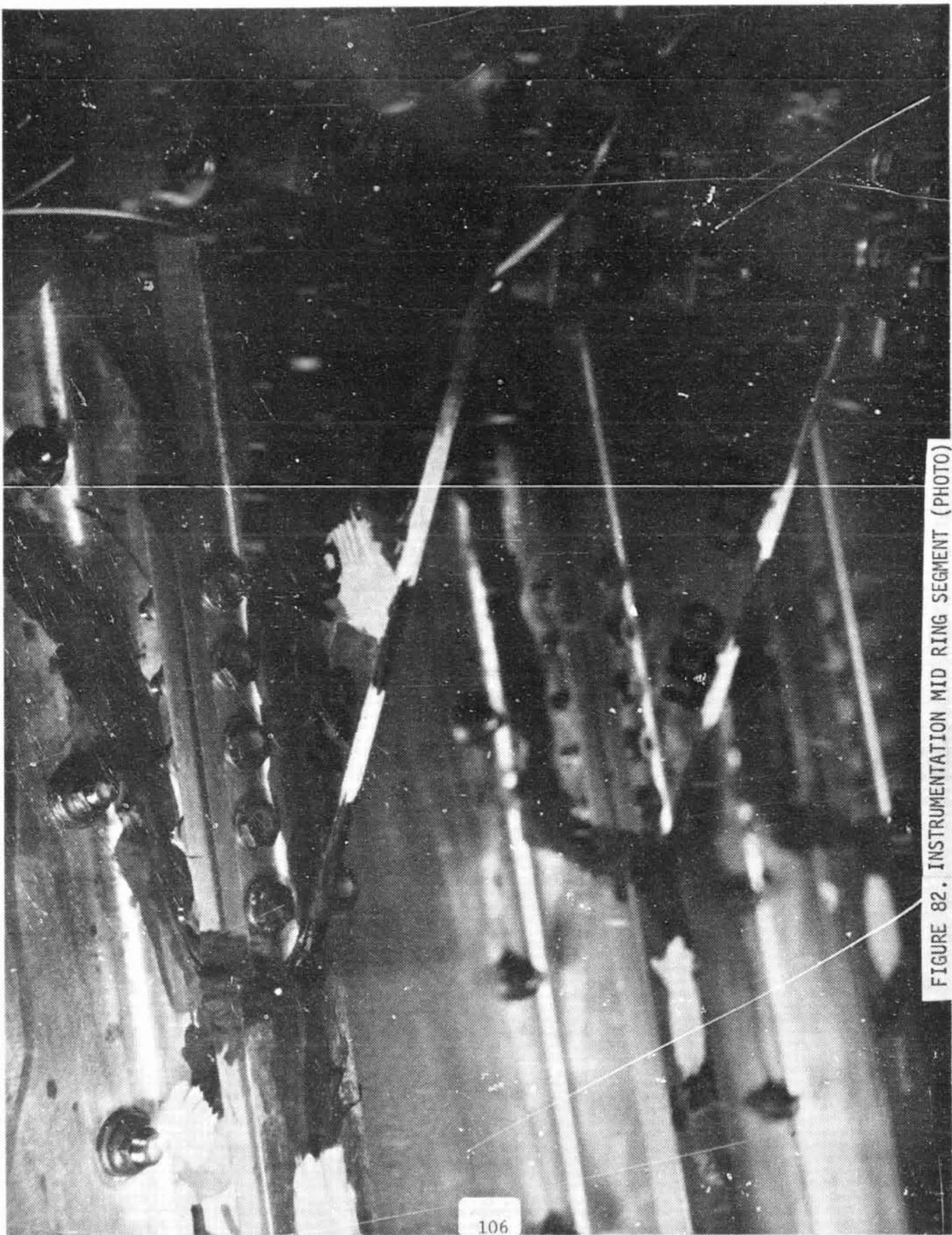


FIGURE 82. INSTRUMENTATION MID RING SEGMENT (PHOTO)

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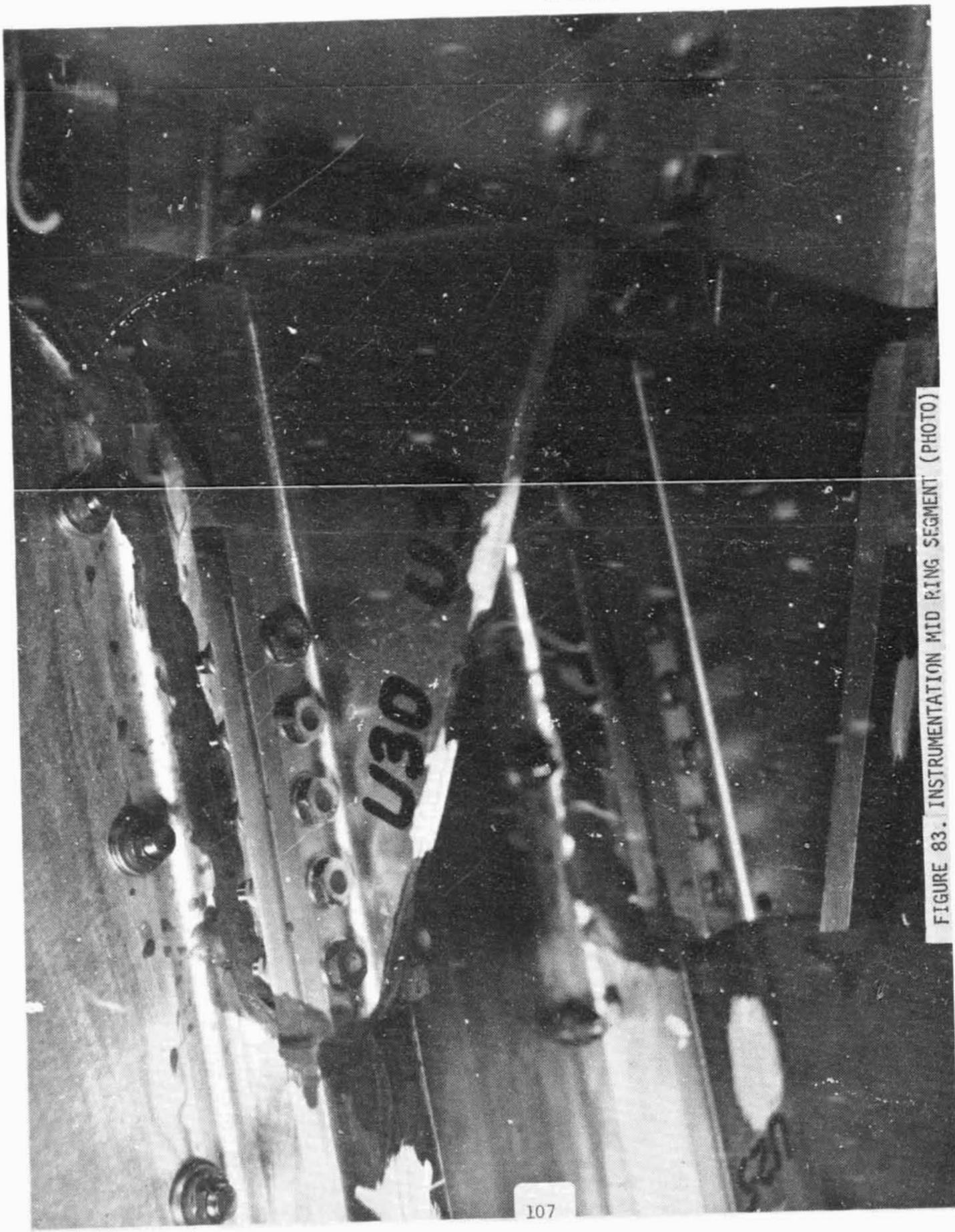


FIGURE 83. INSTRUMENTATION MID RING SEGMENT (PHOTO)

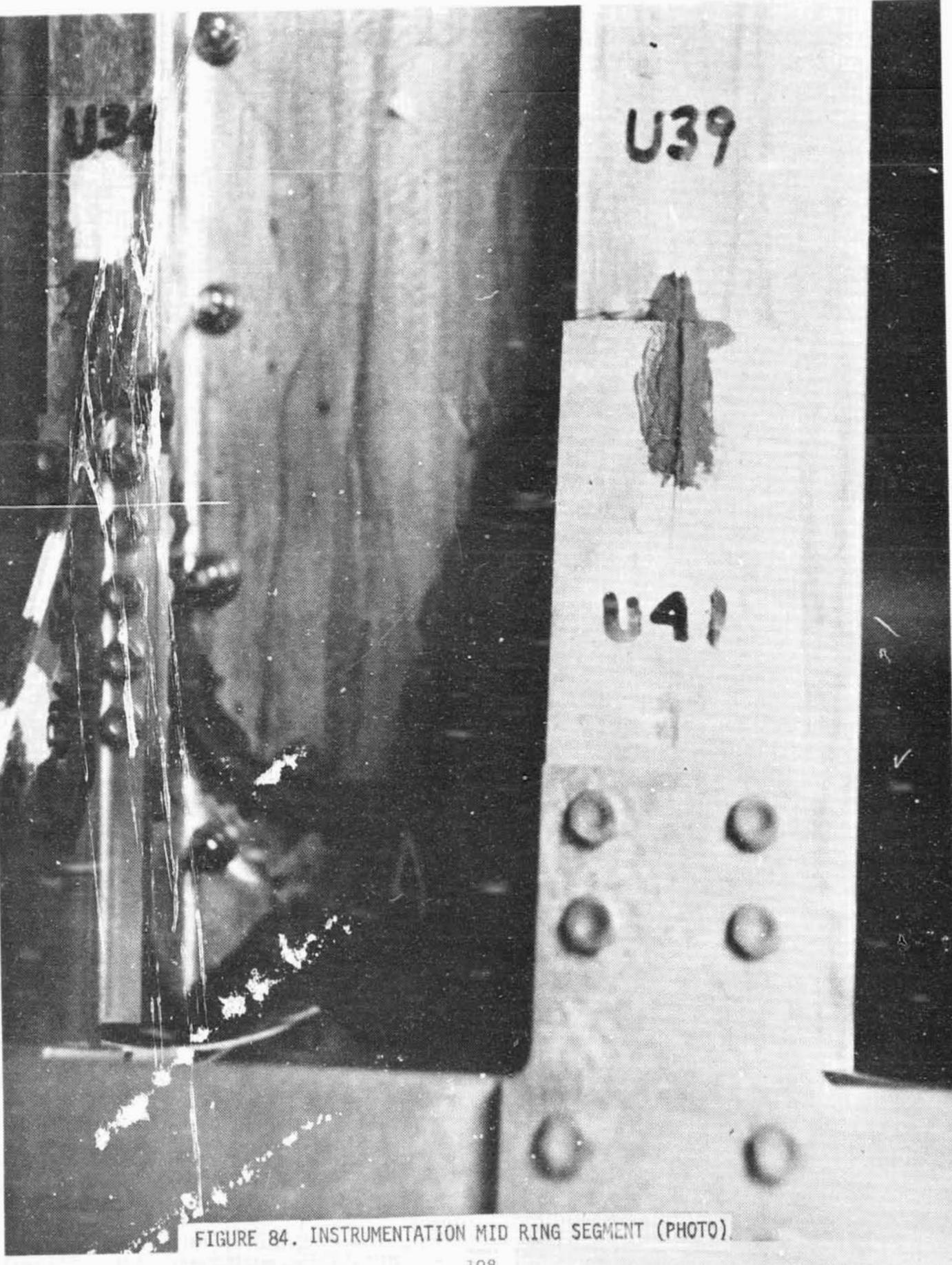
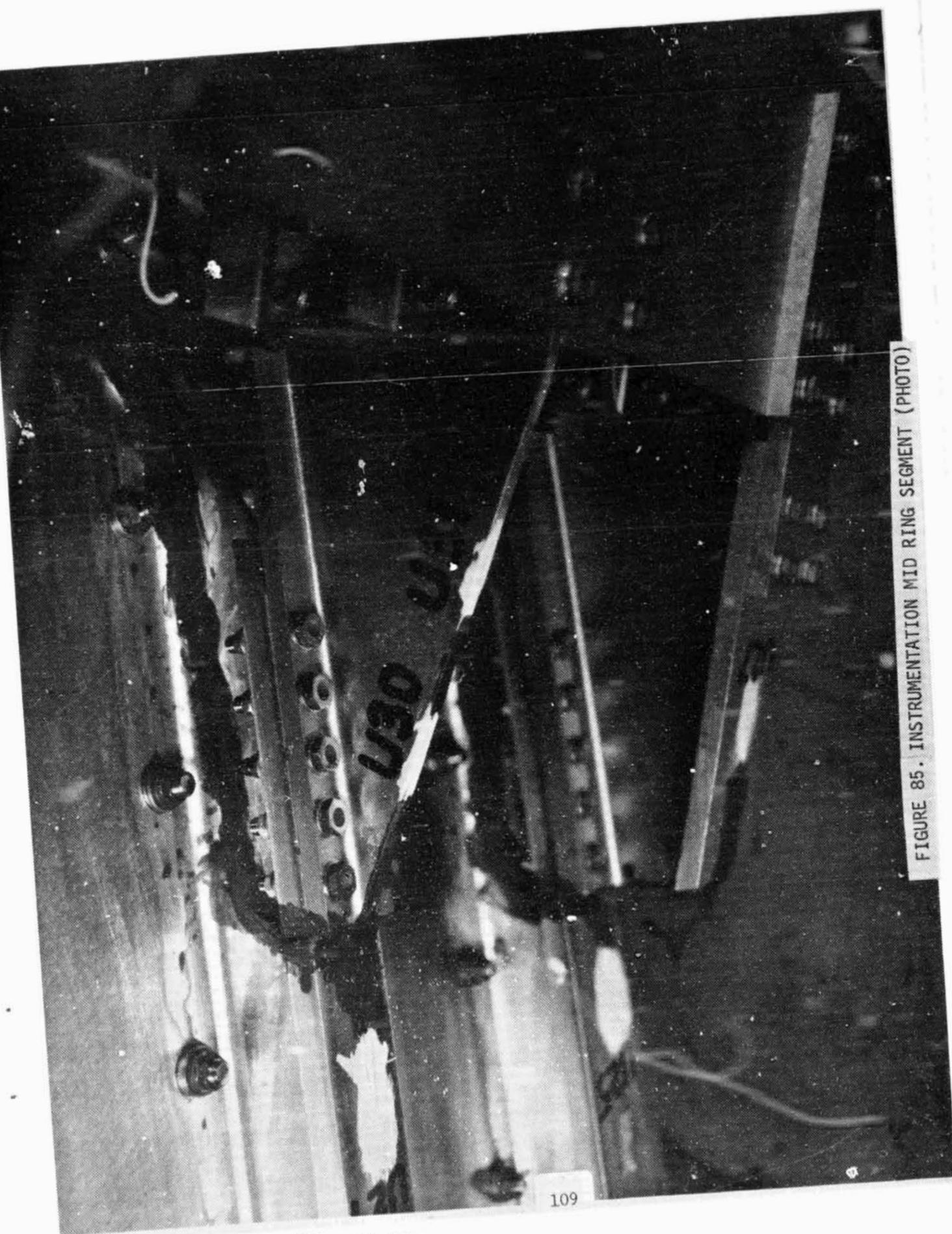


FIGURE 84. INSTRUMENTATION MID RING SEGMENT (PHOTO)

FIGURE 85. INSTRUMENTATION MID RING SEGMENT (PHOTO)



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FIGURE 86. INSTRUMENTATION MID RING SEGMENT (PHOTO)

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FIGURE 87. INSTRUMENTATION MID RING SEGMENT (PHOTO)

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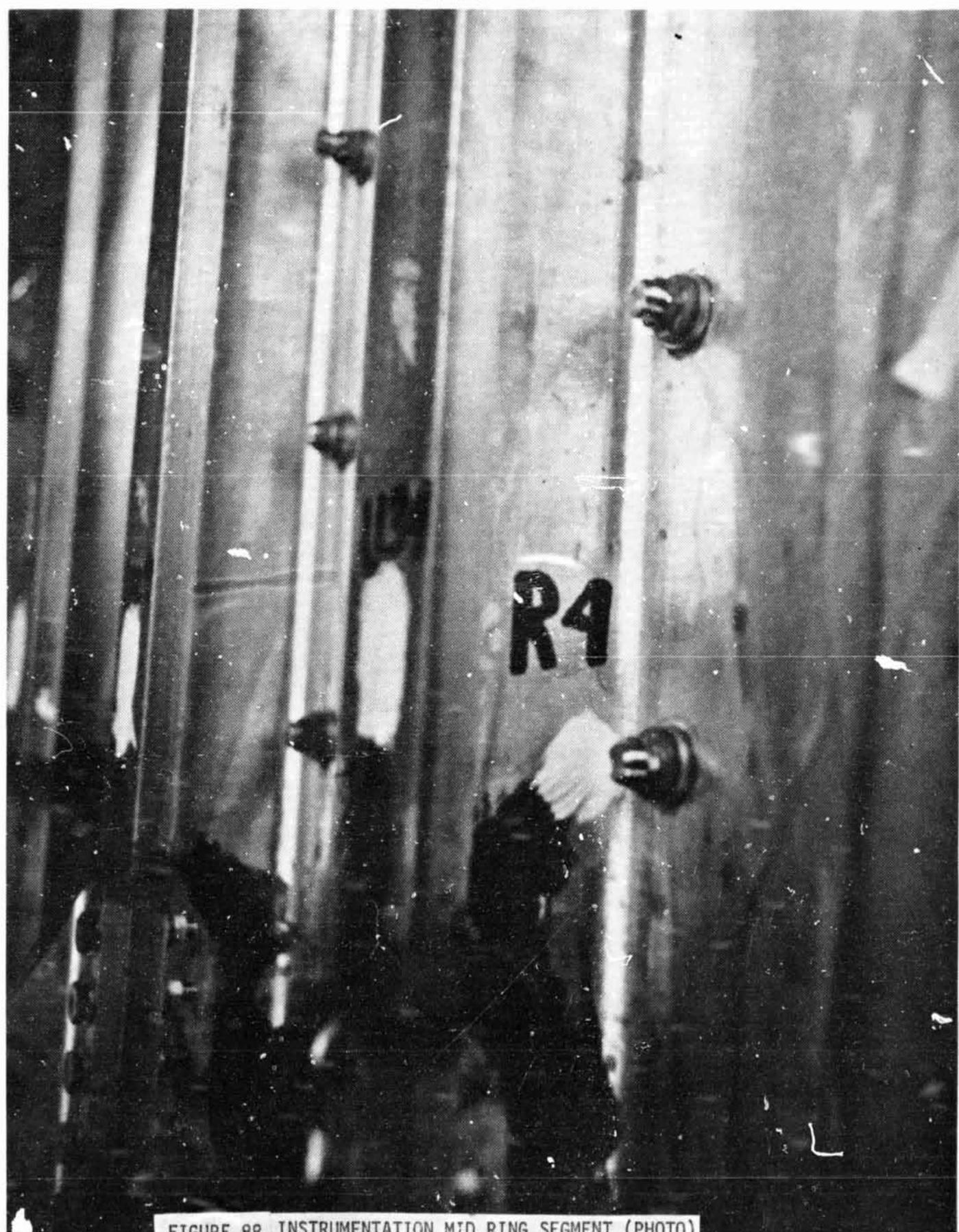


FIGURE 88. INSTRUMENTATION MID RING SEGMENT (PHOTO)

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FIGURE 89. INSTRUMENTATION MID RING SEGMENT (PHOTO)

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RIB 2

SEN

SW

SW

RIB 3

SEN

FIGURE 90. INSTRUMENTATION MID RING SEGMENT (PHOTO)

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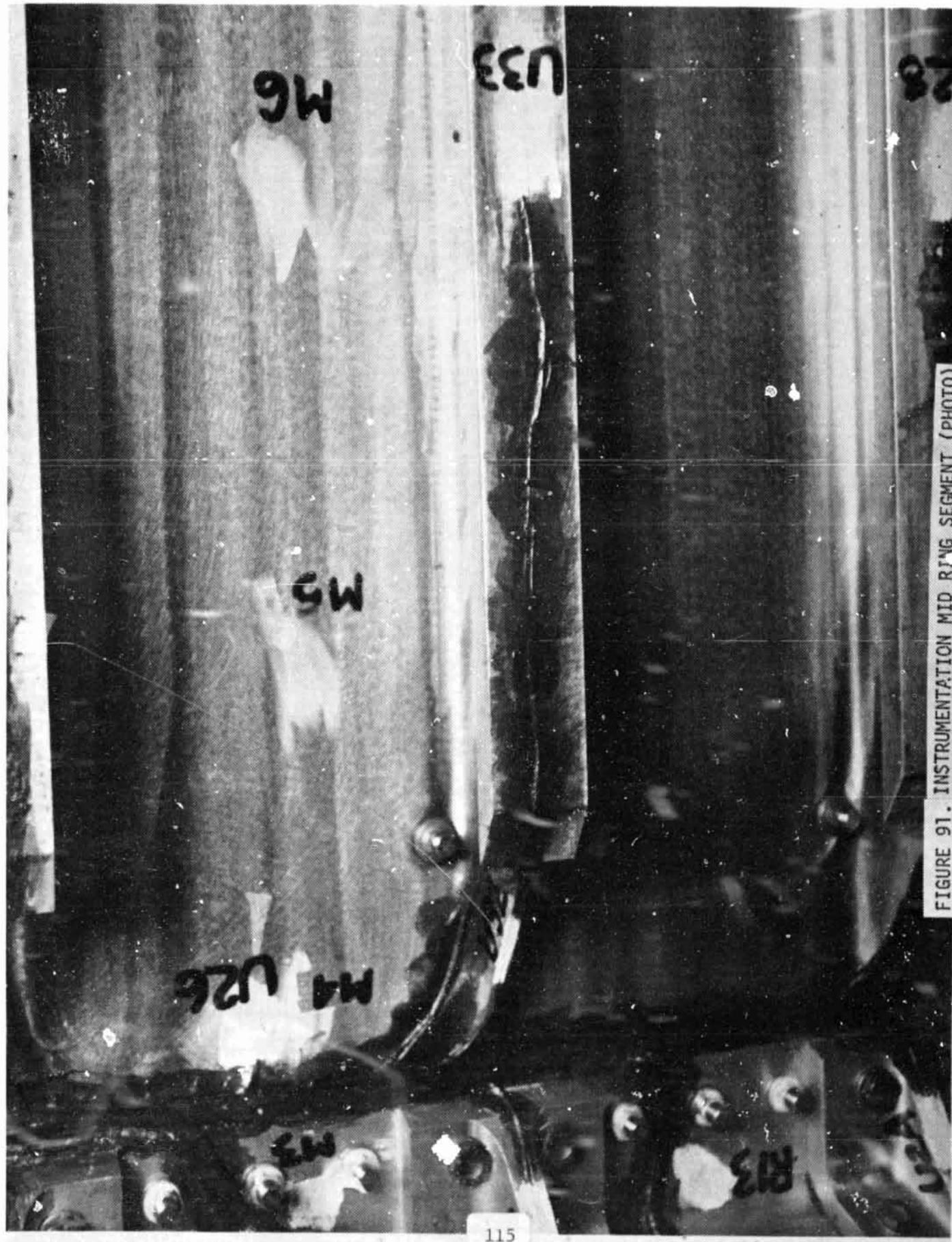


FIGURE 91. INSTRUMENTATION MID RING SEGMENT (PHOTO)

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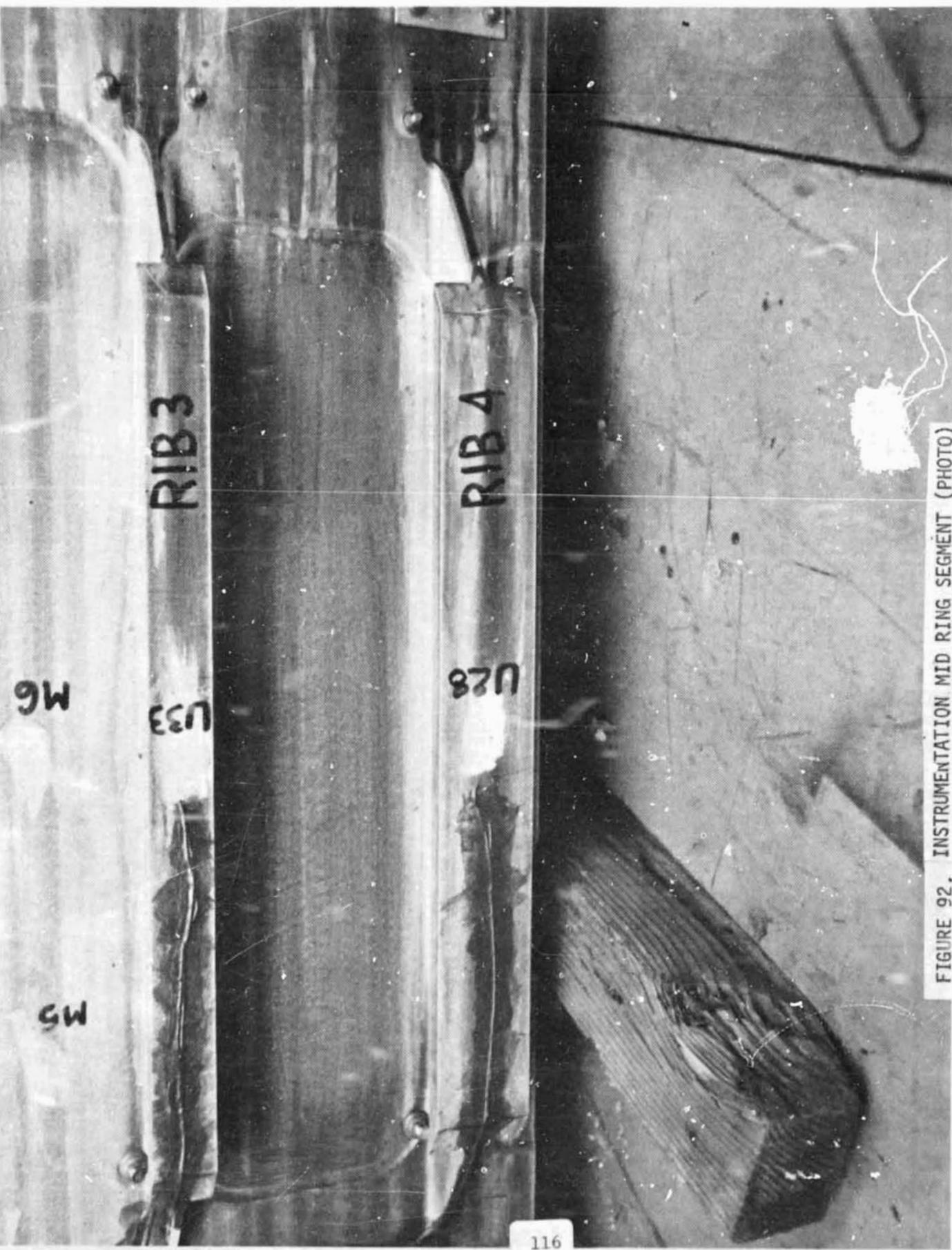


FIGURE 92. INSTRUMENTATION MID RING SEGMENT (PHOTO)

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FIGURE 93. INSTRUMENTATION MID RING SEGMENT (PHOTO)

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FIGURE 94. INSTRUMENTATION MID RING SEGMENT (PHOTO)

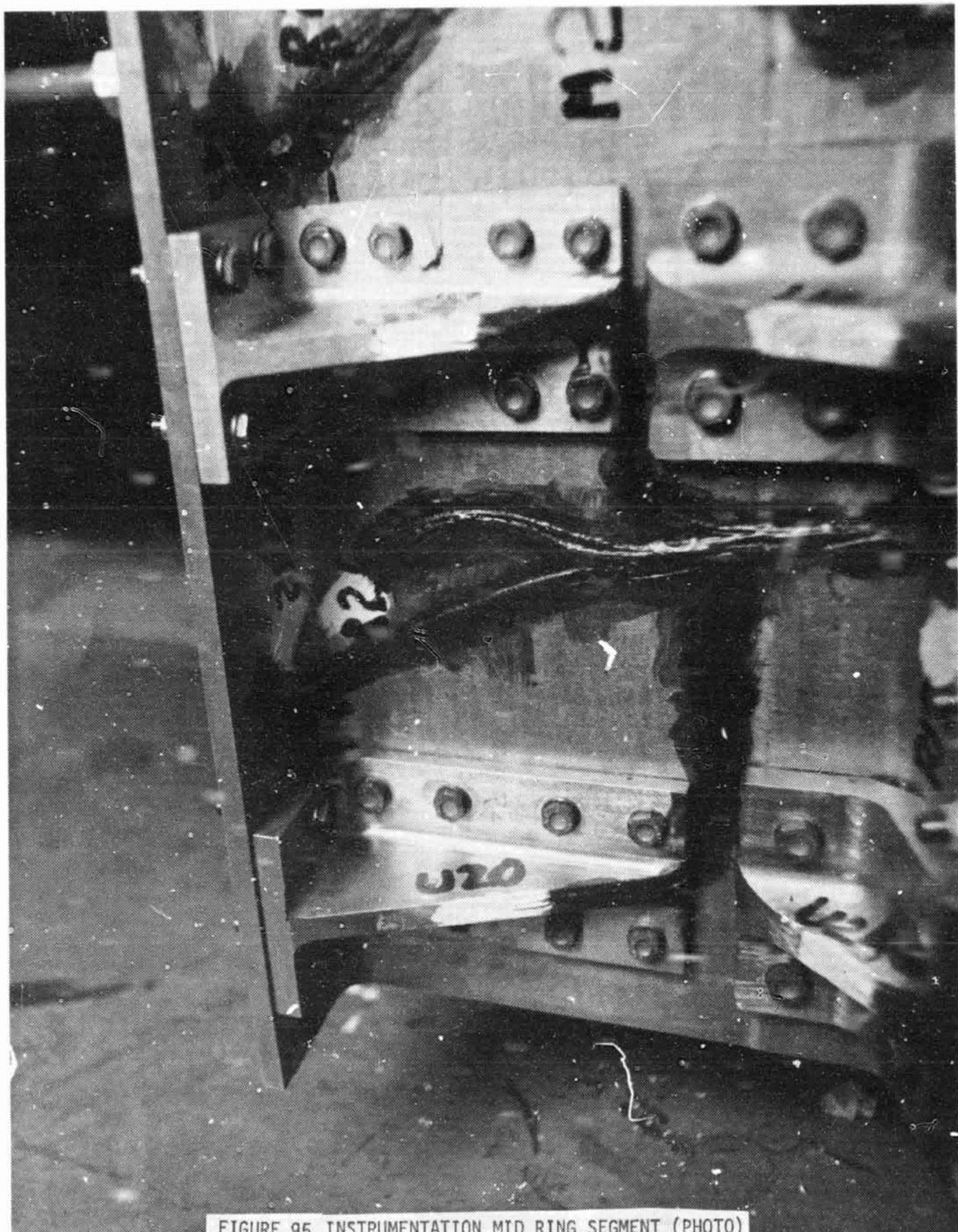


FIGURE 95. INSTRUMENTATION MID RING SEGMENT (PHOTO)

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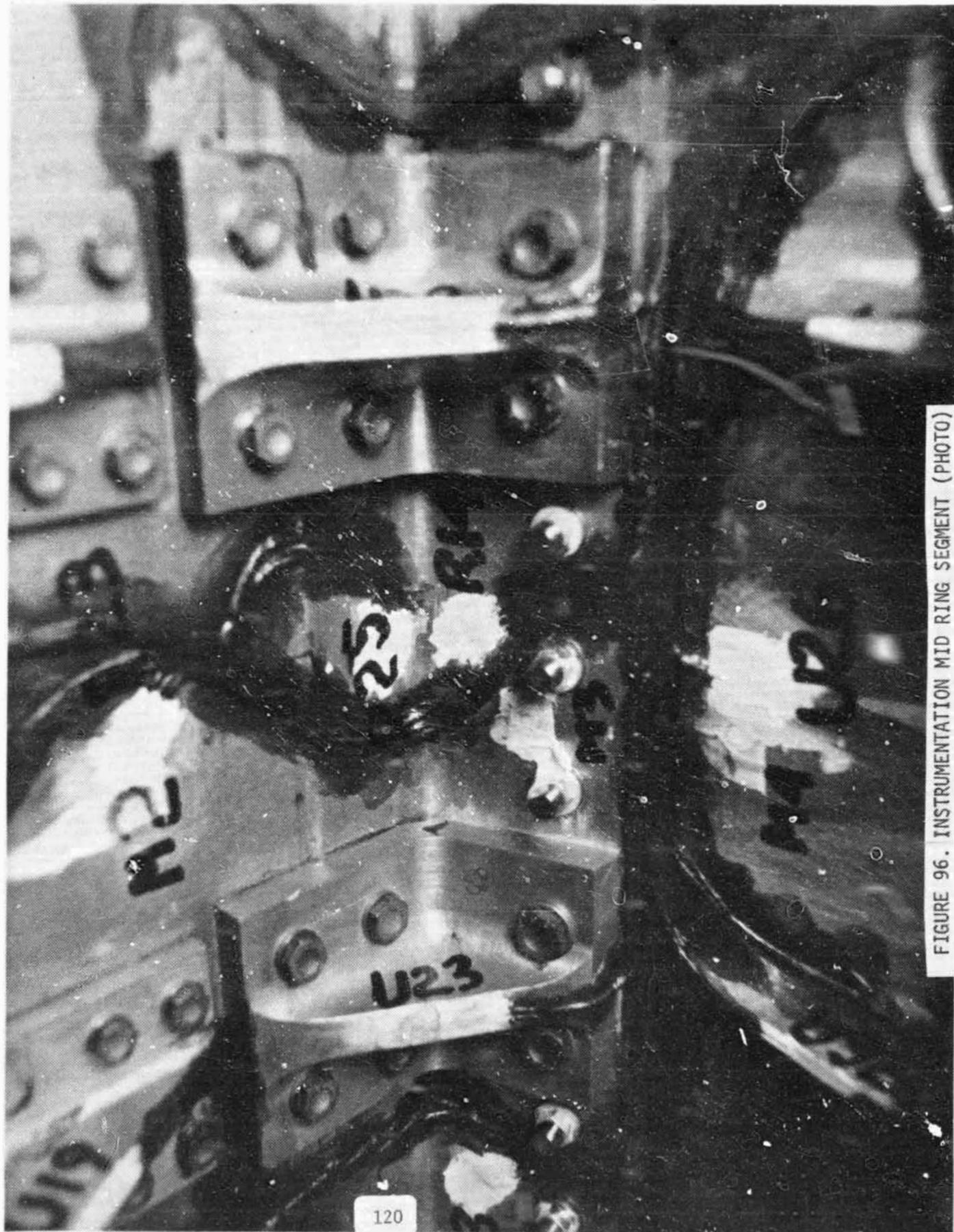


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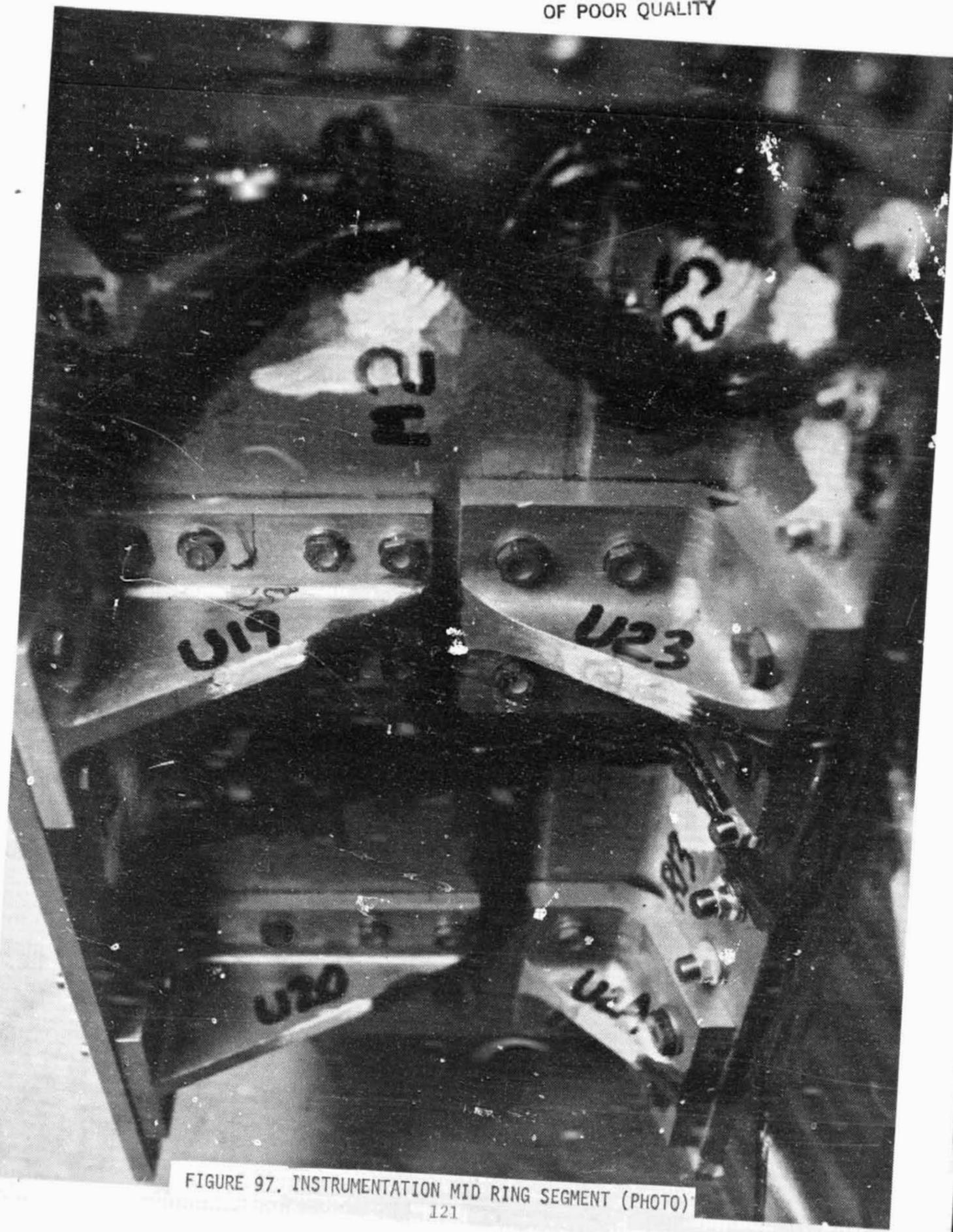


FIGURE 97. INSTRUMENTATION MID RING SEGMENT (PHOTO)



FIGURE 98. INSTRUMENTATION MID RING SEGMENT (PHOTO)

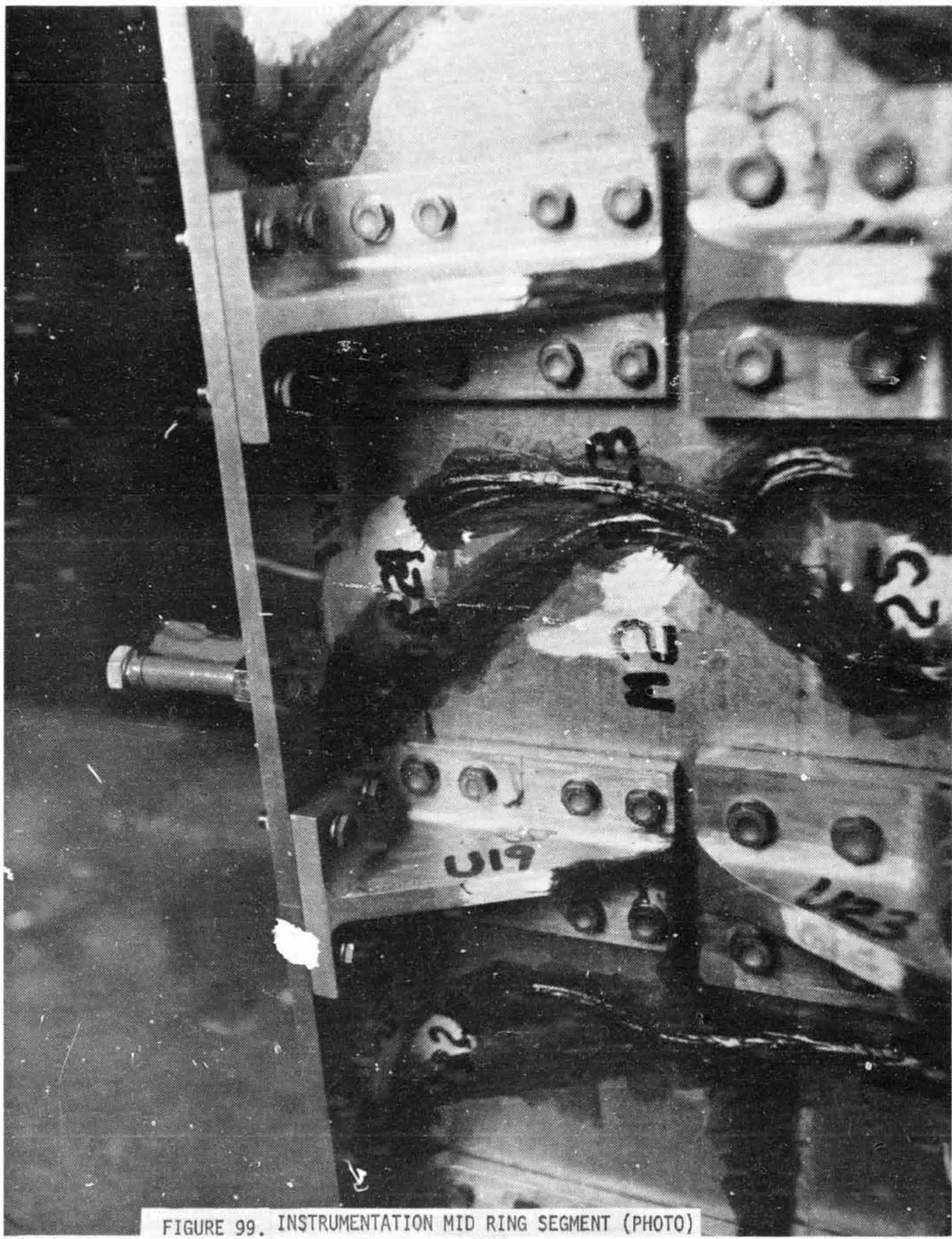


FIGURE 99. INSTRUMENTATION MID RING SEGMENT (PHOTO)

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FIGURE 100. INSTRUMENTATION MID RING SEGMENT (PHOTO)

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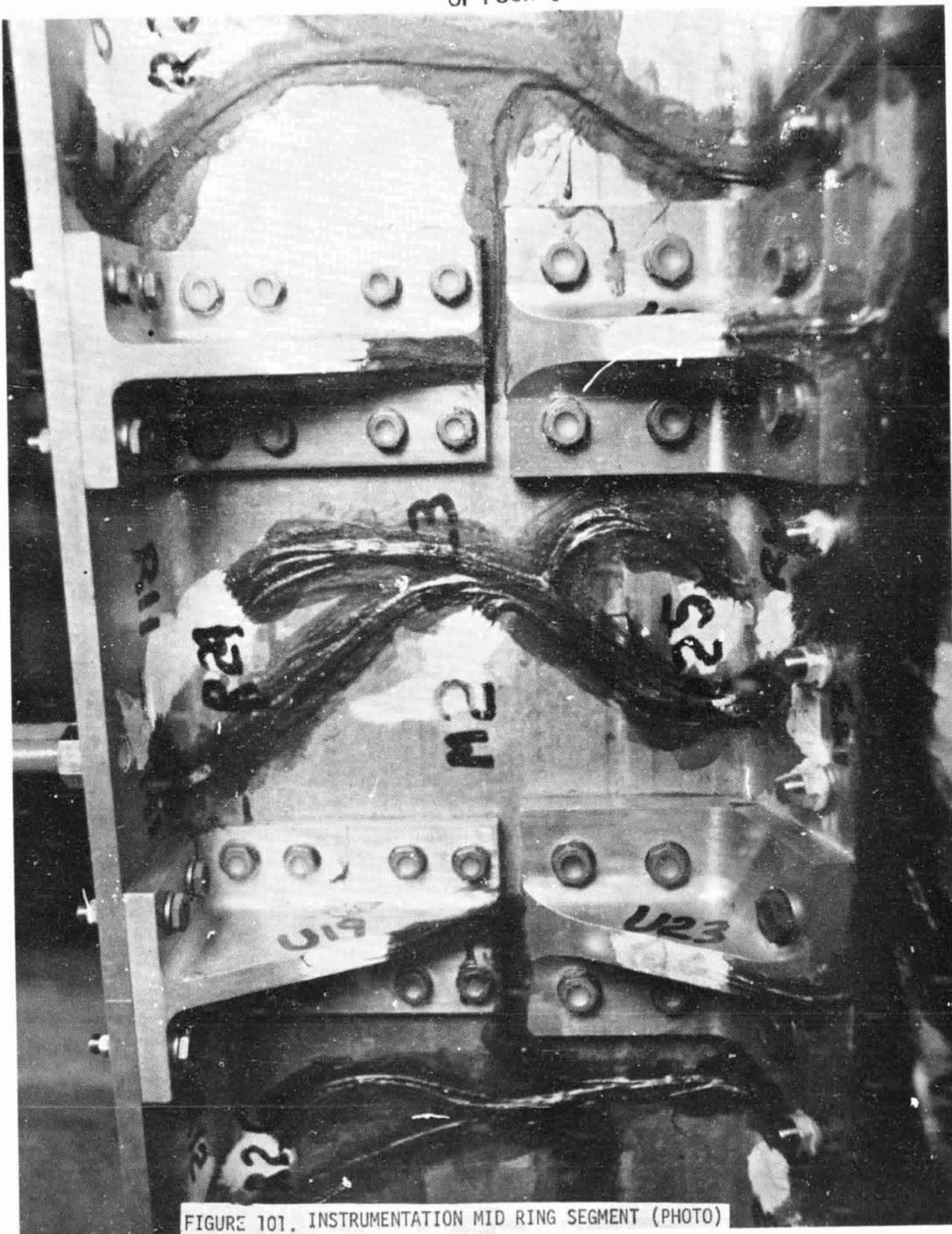


FIGURE 101. INSTRUMENTATION MID RING SEGMENT (PHOTO)

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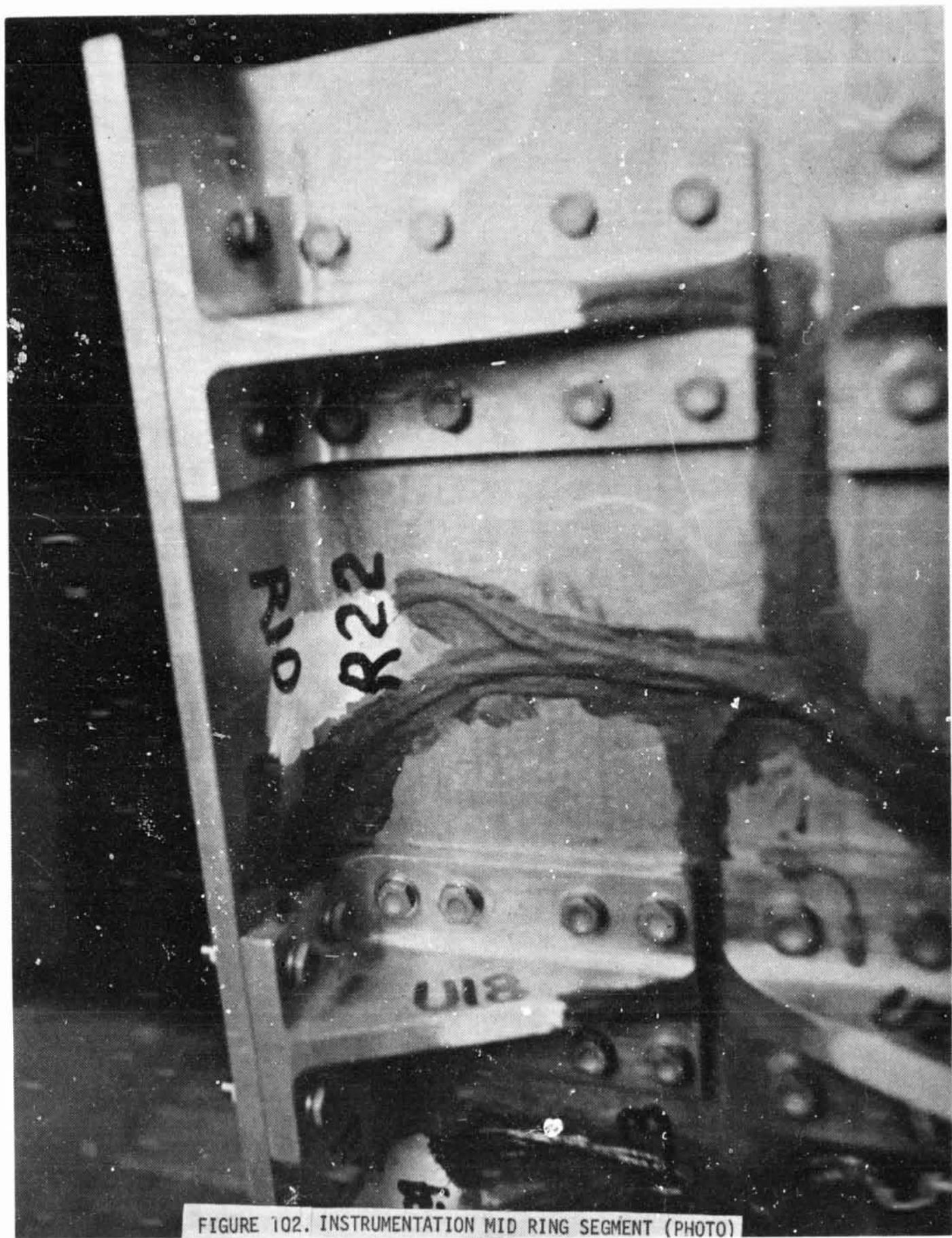


FIGURE 102. INSTRUMENTATION MID RING SEGMENT (PHOTO)

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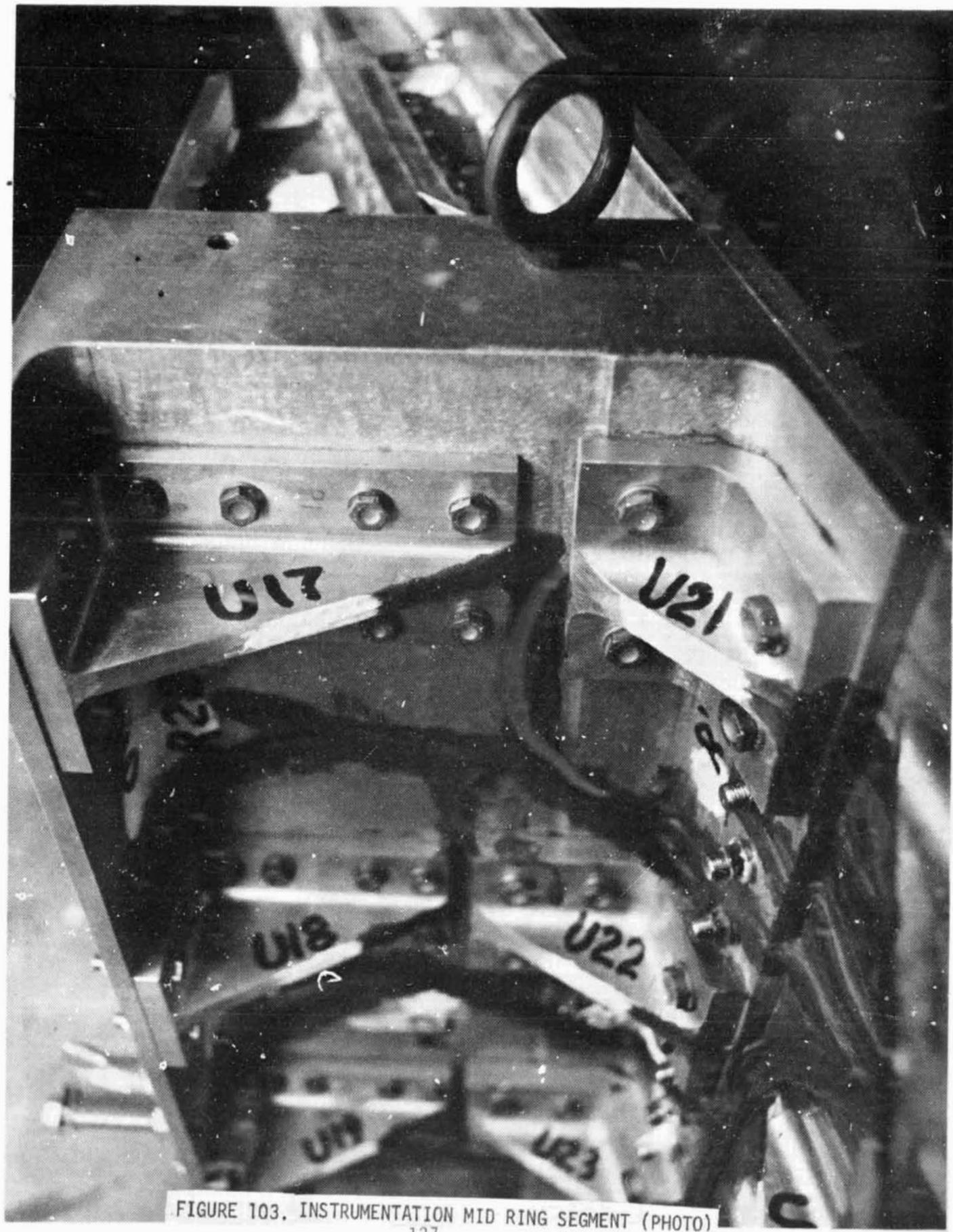


FIGURE 103. INSTRUMENTATION MID RING SEGMENT (PHOTO)

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FIGURE 104. INSTRUMENTATION MID RING SEGMENT (PHOTO)

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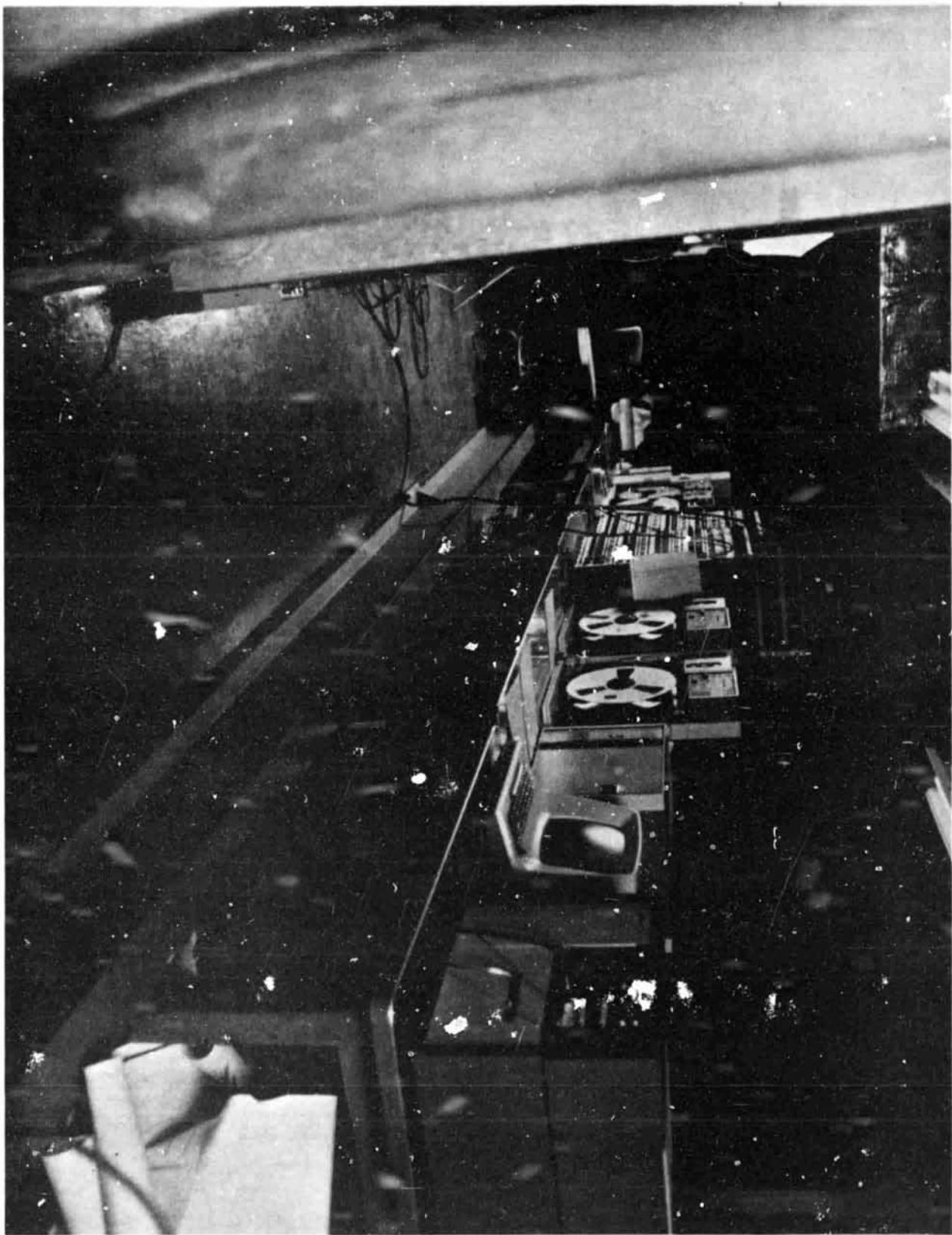


Figure 105. DATA RECORDING SYSTEM

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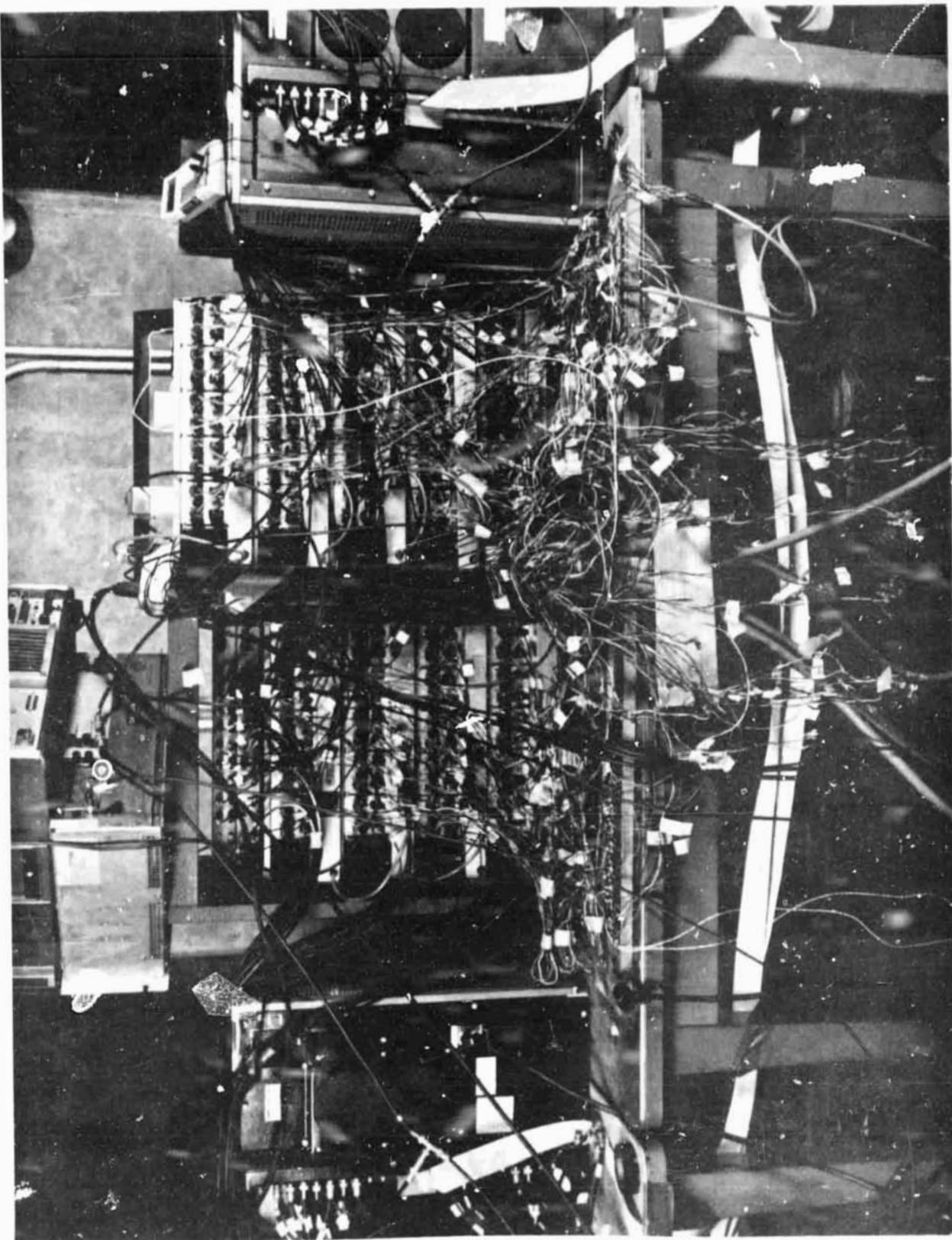


Figure 106. Signal Conditioning Equipment (Rear View)

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SECTION IV - TEST FACILITY

This test was conducted in the Hydroballistics Tank at the U.S. Naval Surface Weapons Center, White Oak, Maryland. This tank is 35 feet wide, 100 feet long and 75 feet deep with a water depth variable from zero to 65 feet. To preserve water clarity the tank is lined with stainless steel and the water is continuously filtered. A two foot thick reinforced concrete honeycomb structure surrounds the tank and is designed to permit reduction of air pressure above the water for model scaling. Steam ejectors located on the building roof are used to evacuate the tank for pressure scaled test. The steam ejectors were not used for this test. All testing was accomplished at atmospheric pressures.

Depending upon water level, access to the tank is obtained either through a door in the bottom of the tank, two personnel hatches in the ceiling, or by removing one of nine 3-foot diameter gun ports located in the north wall and ceiling. Work inside the tank is performed from either a raft, a catwalk, or a movable bridge 6.5 feet high by 10 feet wide which spans the 35 foot width of the tank at the 61 foot elevation. For photographic or visual observations 16 inch diameter portholes are located 11 feet on center in the tank floor, walls, and ceiling. Figures 107, 108, and 109 are illustrations of the hydroballistics tank.

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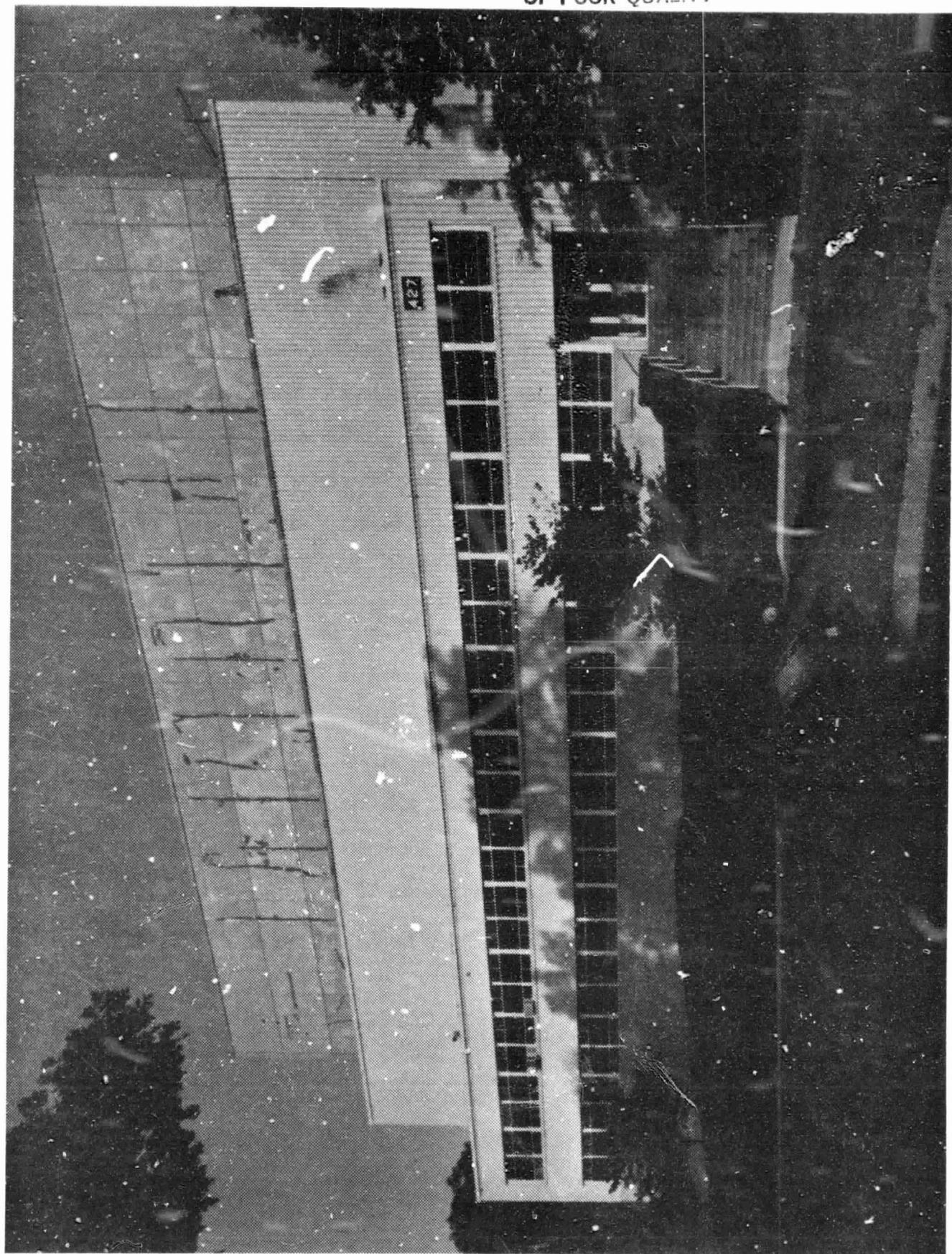


FIGURE 107. HYDROBALLISTICS TANK, NAVAL SURFACE WEAPONS C_L "R
WHITE OAK, MARYLAND

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Operating Characteristics

Tank length	100 feet
Tank width	35 feet
Tank height	75 feet
Water depth	65 feet
Launcher	Powder gas gun (compressed gas launcher for low velocities)
Projectile	3 inch, 6 pounds maximum
Velocity	1000 feet per second
Launch angle	Vertical to horizontal
Instrumentation	Fire control unit to synchronize launcher-camera operation, multi-channel tape recorder system to monitor telemetry signals, optical whip recorder to measure angular motion of water entry, high speed 16 mm and 35 mm cameras to record the entire model trajectory.



Inside view of the Hydroballistics Tank

FIGURE 109. INSIDE VIEW OF HYDROBALLISTICS TANK

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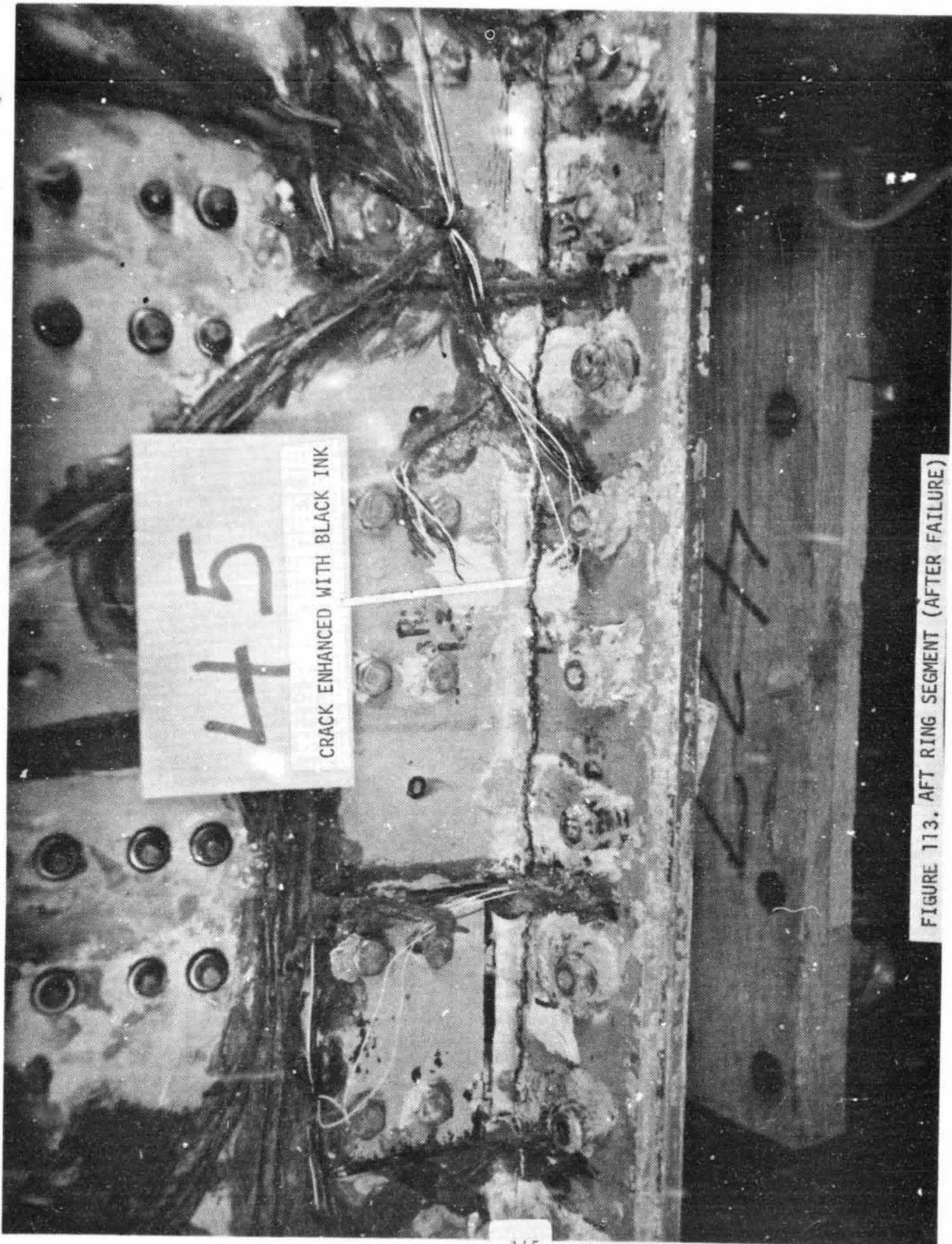


FIGURE 113. AFT RING SEGMENT (AFTER FAILURE)

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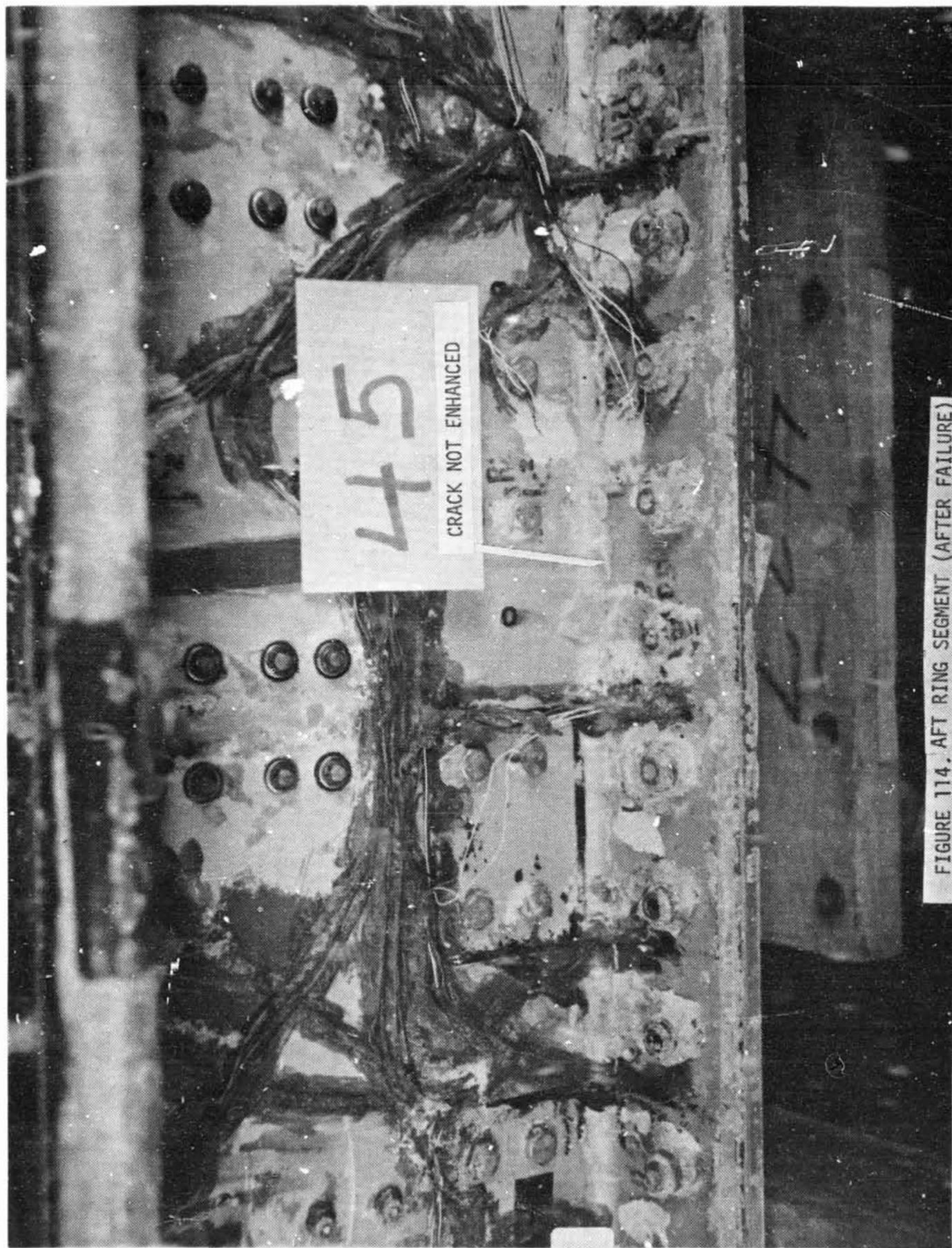


FIGURE 114. AFT RING SEGMENT (AFTER FAILURE)

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CRACK ENHANCED WITH BLACK INK

FIGURE 115. AFT RING SEGMENT (AFTER FAILURE)

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FIGURE 116. AFT RING SEGMENT (AFTER FAILURE)

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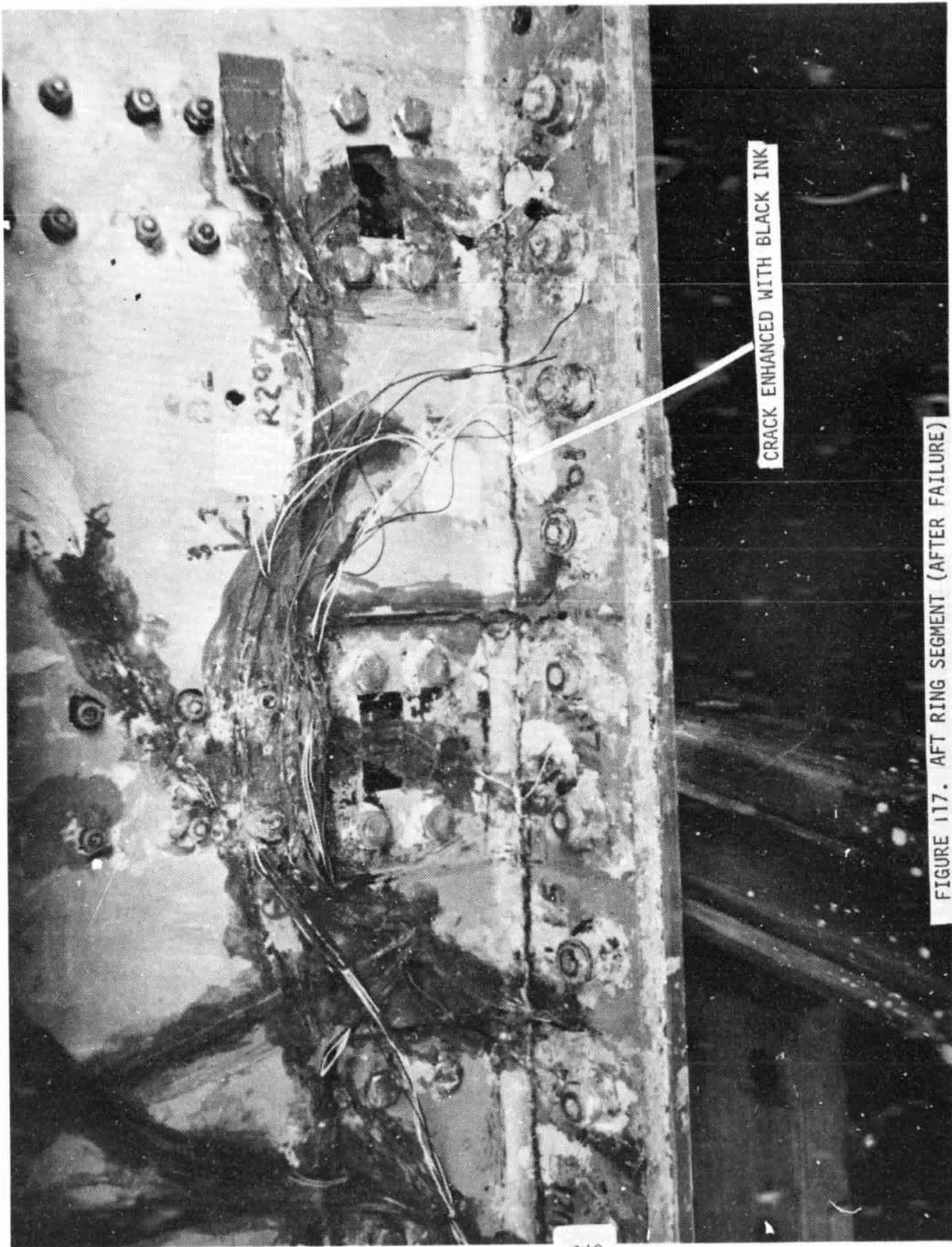
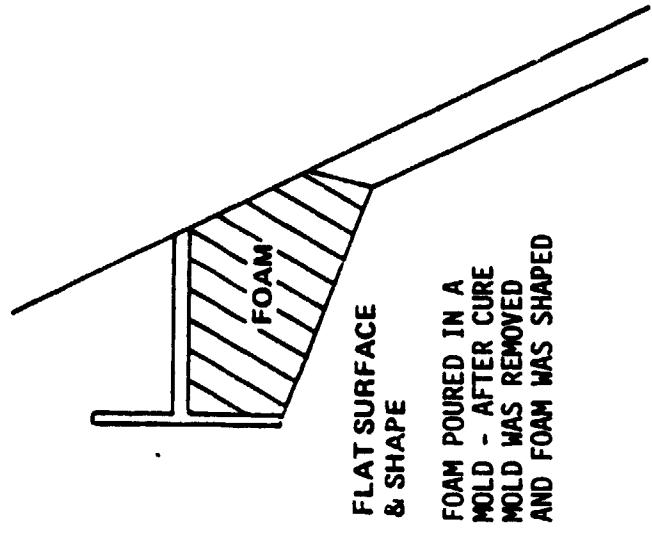


FIGURE 117. AFT RING SEGMENT (AFTER FAILURE)

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SHAPE II



FOAM POURED IN A
MOLD - AFTER CURE
MOLD WAS REMOVED
AND FOAM WAS SHAPED

SHAPE I

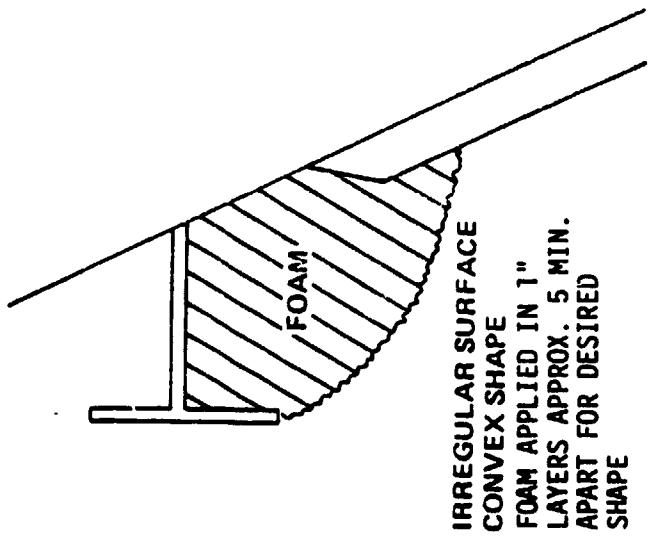


Figure 118

MID RING FOAM CONTOUR SHAPE DEFINITION

SECTION VII - TEST OPERATIONS

The aft ring and mid ring aft skirt segments of the SRB (2 models) were fabricated under the direction of United Space Boosters, Inc., Huntsville, Alabama for NASA. The models were then turned over to Chrysler for instrumentation and calibration. Chrysler personnel transported the models to the Naval Surface Weapons Center, White Oak, MD. On arrival at White Oak the instrumentation calibration was again checked.

Barrel rods previously fabricated under the direction of Chrysler were attached to each model. After the weights of the models were recorded the models were installed into the Hydroballistics Tank. This was accomplished by lowering the water level in the tank to allow a raft to float under the movable bridge within the tank. Prior to the model installation a wooden deck was fabricated on top of this movable bridge. With the raft positioned under the personnel hatch - located in the southeast ceiling of the tank, the models were lowered and loaded on the raft using a chain fall. The raft and model were then floated under the movable bridge to a manhole located in the center ceiling of the tank. A bridge crane located outside the tank was then centered over this manhole. The bridge crane hook was then lowered through the manhole into the tank then attached to the model on the raft. The hook and model were then raised to a height near the ceiling to allow the raft to be floated from under the hook and the movable bridge to be rolled under the manhole and model. When the movable bridge was under the model, the model was then lowered to the wooden deck on the bridge. The wooden deck served as a work platform for installing the barrel rods, instrumentation repairs or changes, and for foaming

operations. All foam and cork applications were accomplished on the wooden deck using a portable exhaust system. With the models in the tank, the water level was then raised to the 61 ft. height, instrument cables were fed down into the tank and reconnected to the models using silicone grease on the connectors to insure waterproofing. Models were loaded from the wooden deck onto the raft in the same manner using the crane hook through the manhole and moving the bridge. The raft was used to move the models under the gun for loading into the gun barrel.

Each model was then loaded into the gun using a chain fall, dropped from the tank top through the gun barrel, and attached to an eye bolt located on the top of the barrel rod. The chain fall was then raised, and the barrel rod was fed into the 6" gun barrel. A safety rope was then attached to the adapter plate and fed through the top of the tank and secured to protect against accidental dropping of the model. With the model in position in the gun, 4 raps of 600 lbs. kevlar line was attached to each side of the model adapter plate. (6-raps were used in the mid ring segment). This was accomplished using 2-eye bolts located on each side of the adapter plate and 2-eye bolts on the gun barrel. With the kevlar line secured, the chain fall was then detached from the top of the barrel rod. This was accomplished from the top of the tank. The model was then held by the kevlar line. With the model secured to the 6" gun barrel and the chain fall removed, another chain host was then used to raise the 6" gun barrel into the breech. Two pins were used to secure the gun barrel into the breech. The second chain fall and safety rope

were then released and removed. The air gun cylinder located above the breech was then pressurized for firing.

Air gun cylinder pressures were varied to obtain the desired impact velocities. Cylinder pressures were determined from prior calibration data obtained in December 1982 and January 1983. The gun barrel was rotated from the vertical position in order to obtain specific impact angles.

Actual test velocities were calculated using a steel wire secured in a 3/64 inch groove located 1/4 inch from the end of the barrel rod. Two magnetic pick-ups located in the gun barrel near the exit end, supplied the velocity information data.

Prior to each shot two ropes were fastened to the model adapter plate, and the top of the tank. One rope was used as a model stop, and the other was used as a safety backup. The safety rope was also used to raise the model from the water, to the raft for transferring to the wooden deck.

The instrumentation cables were stored along the catwalk rail and fed out when the model was fired into the water. Figures 119 through 184 illustrate the model loading and firing operations as well as foam application.

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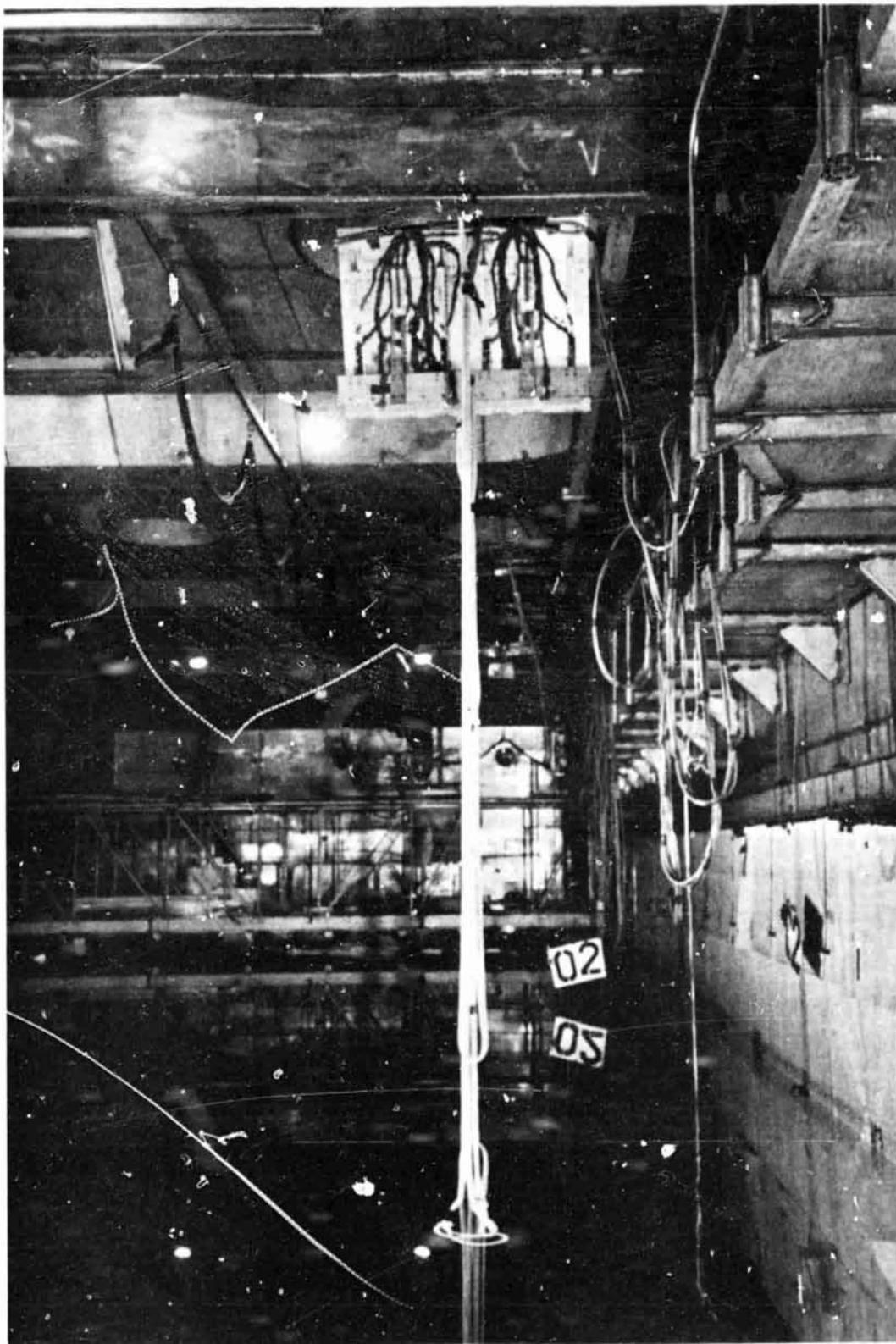


Figure 119. Aft Ring Segment
Model Loaded for Firing

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Figure 120. Aft Ring Segment
Model Loaded for Firing-Side View

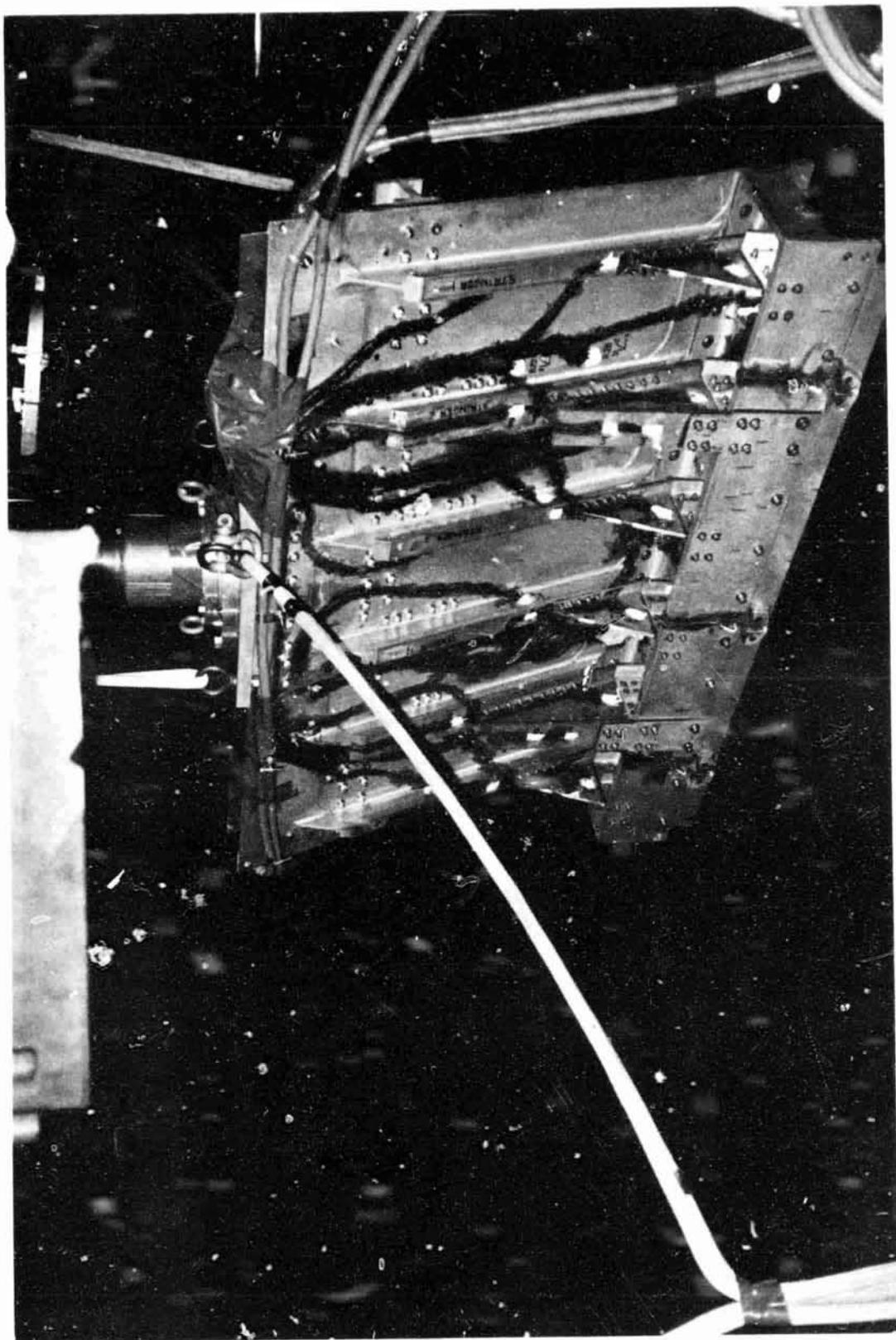


Figure 121. Aft Ring Segment
Model Safety Rope

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Figure 122. Attaching Kevlar Line

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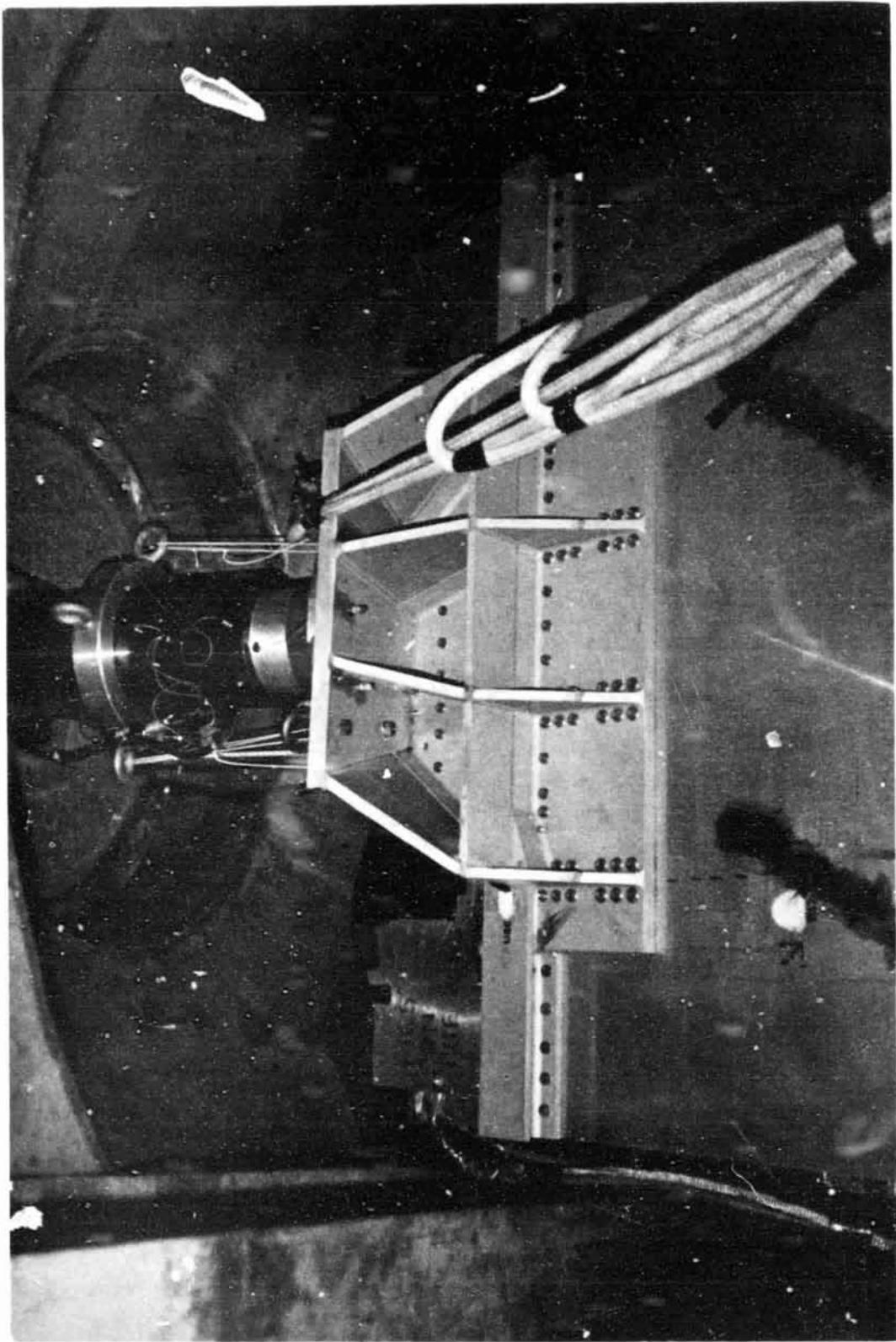


Figure 123. Aft Ring Segment
Model Loaded Details

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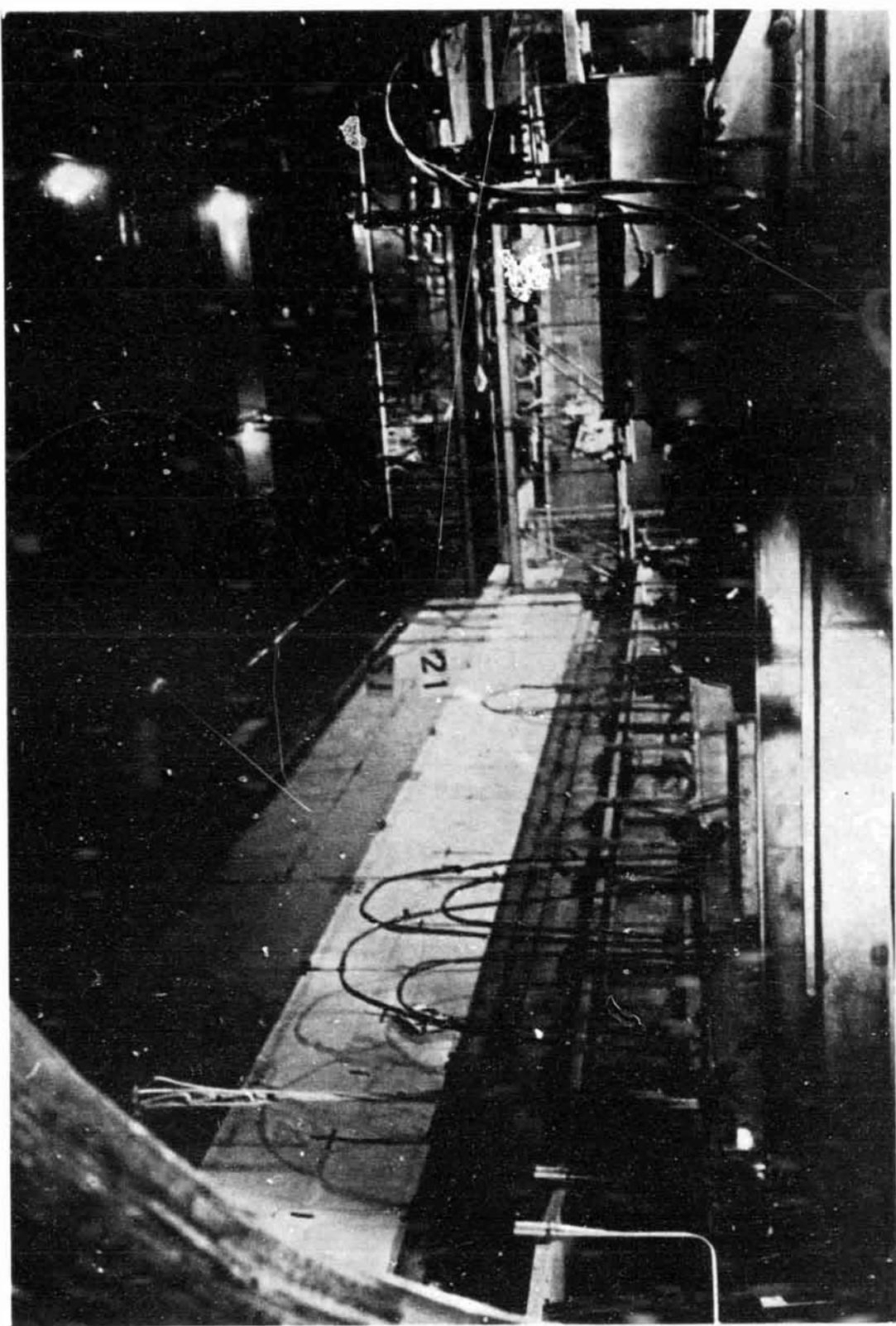


Figure 124. Aft Ring Segment
Mode: Loaded - Ready to Fire

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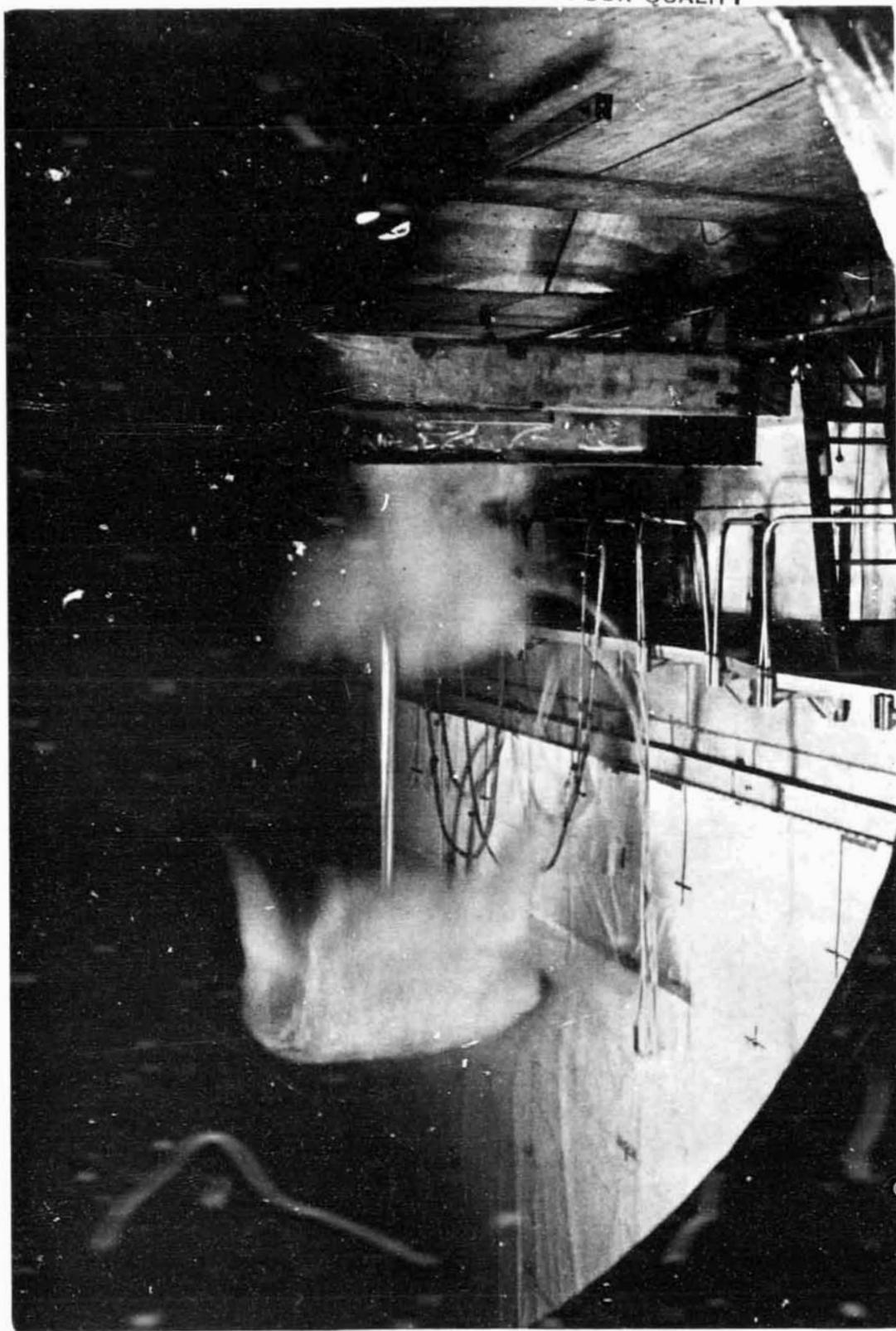


Figure 125. Aft Ring Model
Firing (Imapct)

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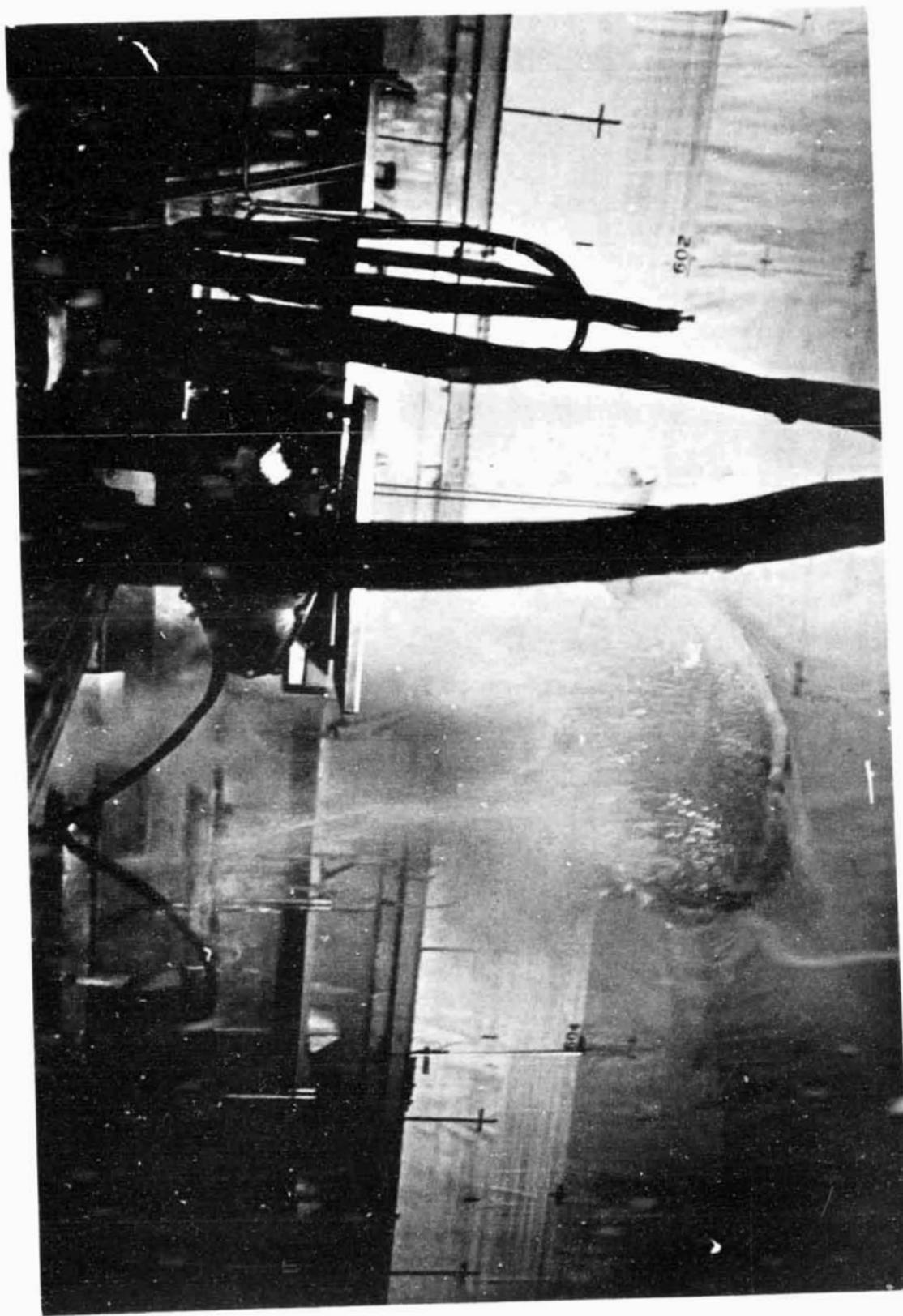


Figure 126. Aft Ring Model
Firing (Cavity Collapse)

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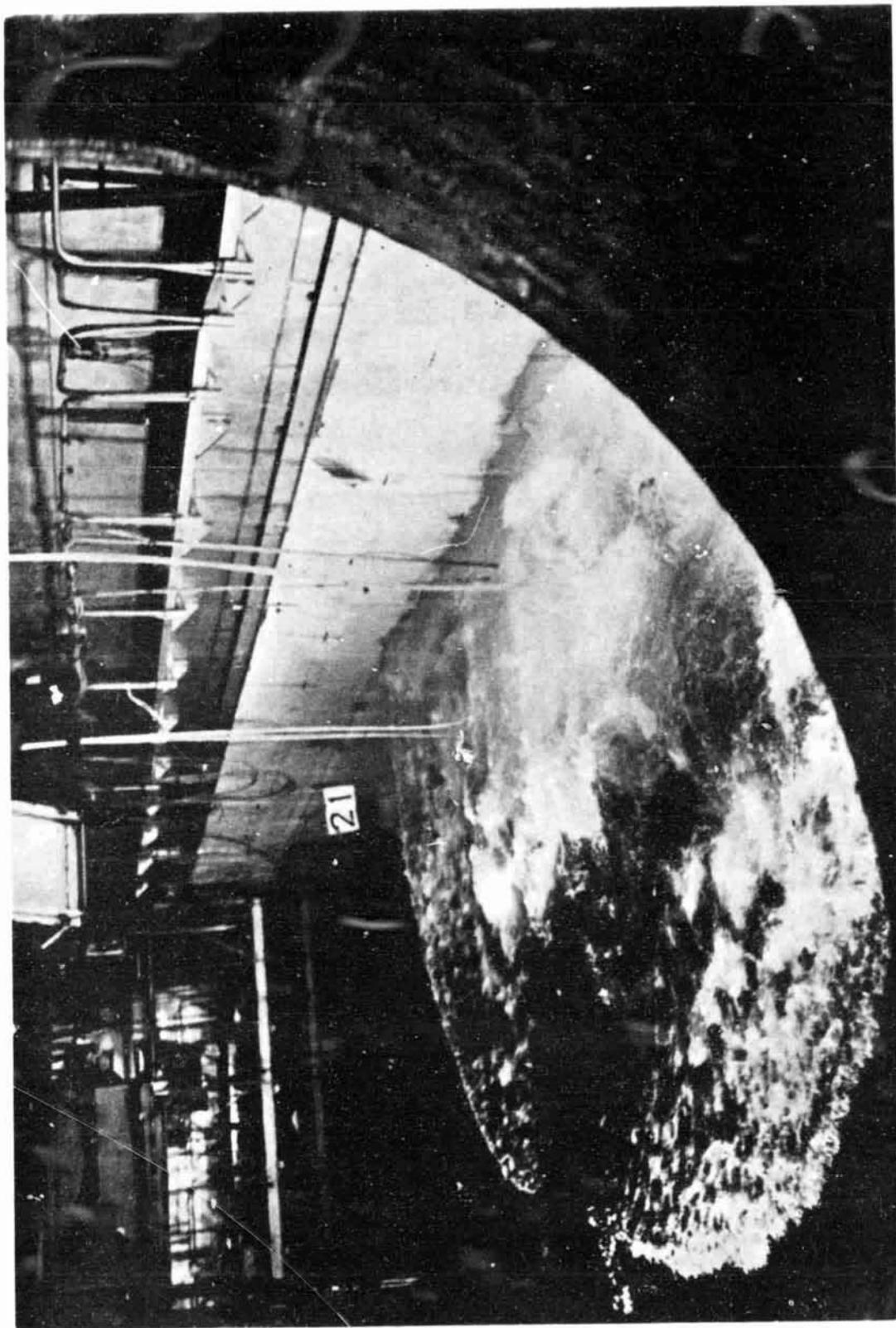


Figure 127. Aft Ring Model
Firing (After Penetration)

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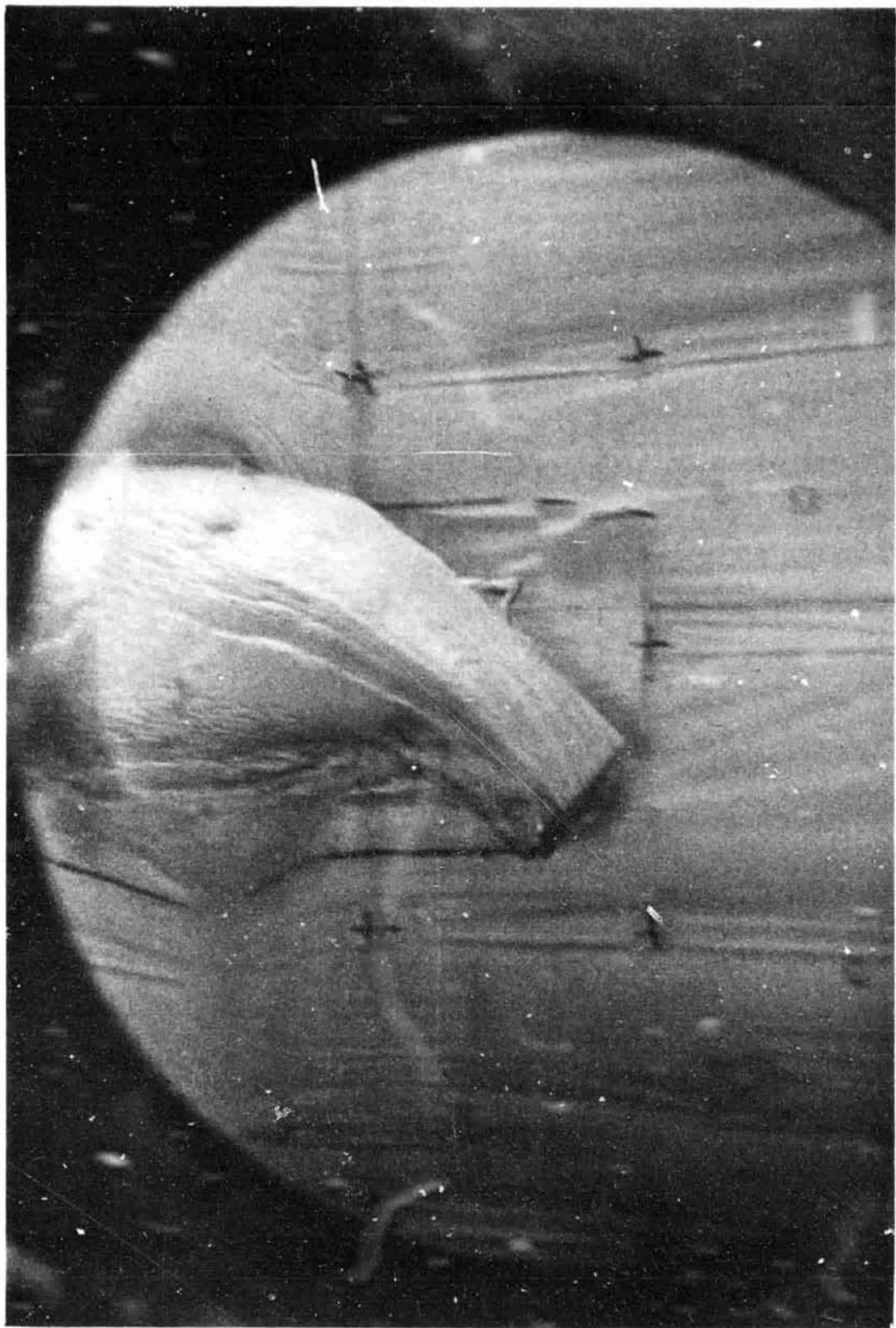


Figure 128. Aft Ring Model
Firing (Under Water)

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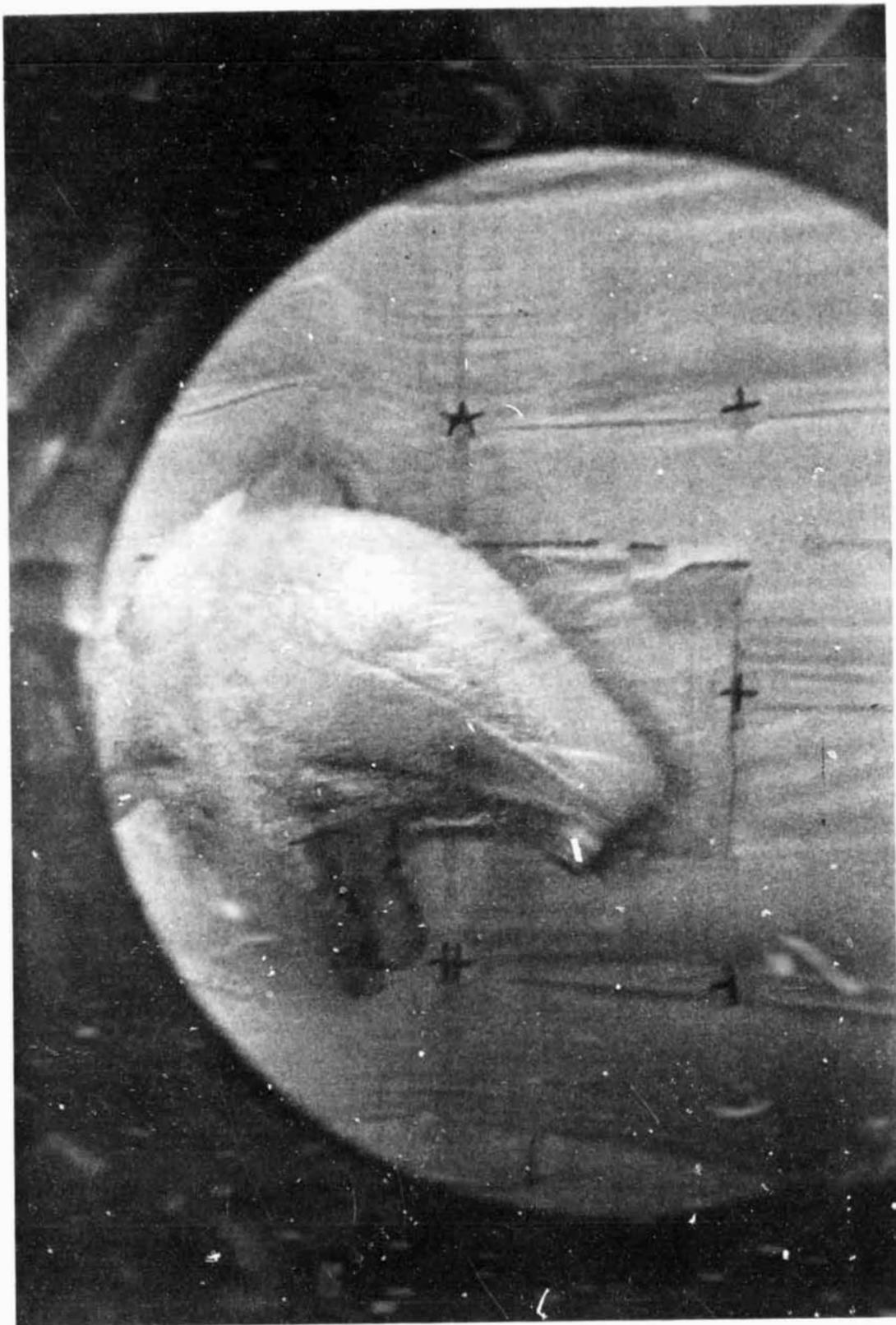


Figure 129. Aft Ring Model
Firing (Under Water)

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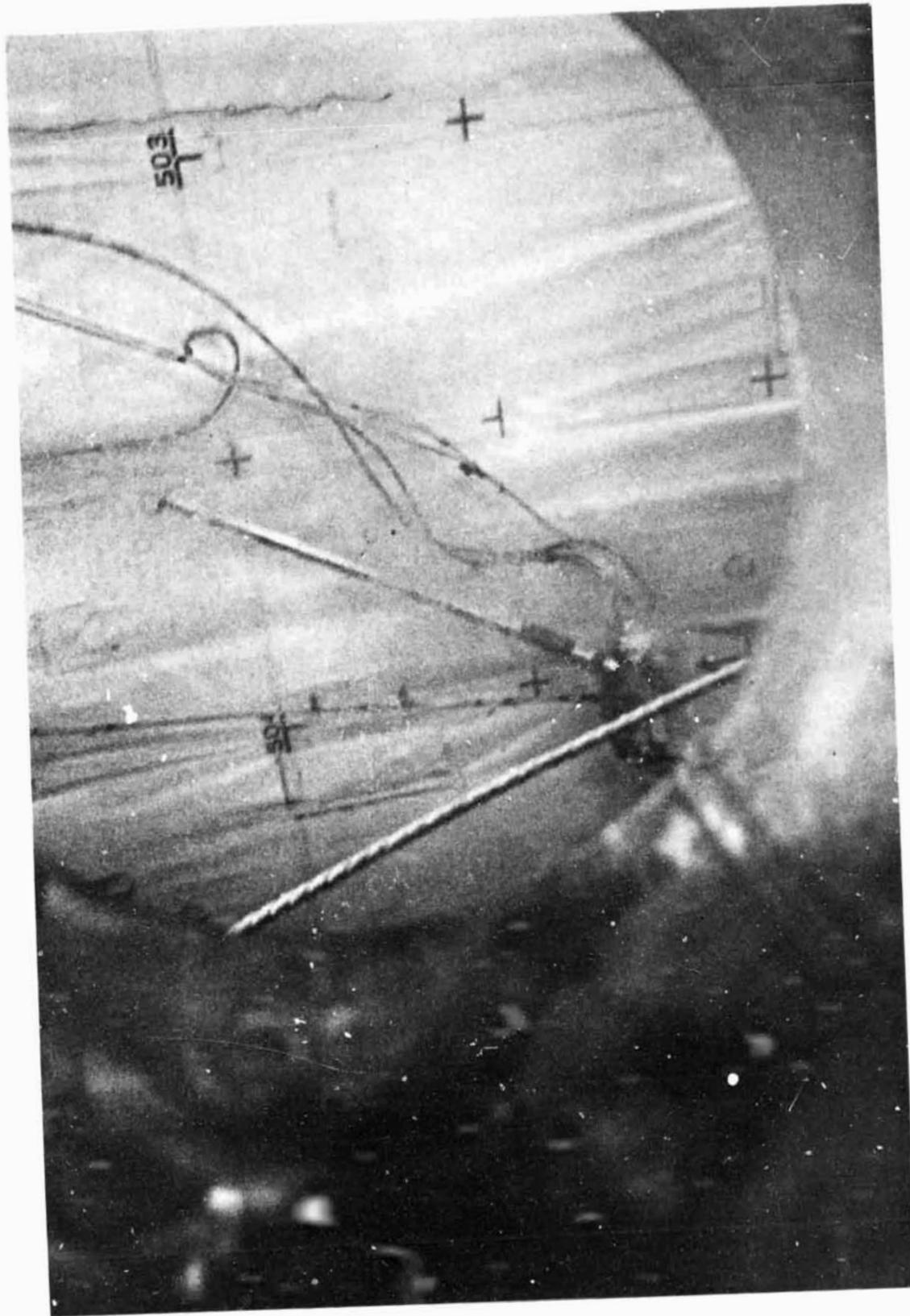


Figure 130. Aft Ring Model
Deceleration (Under Water)

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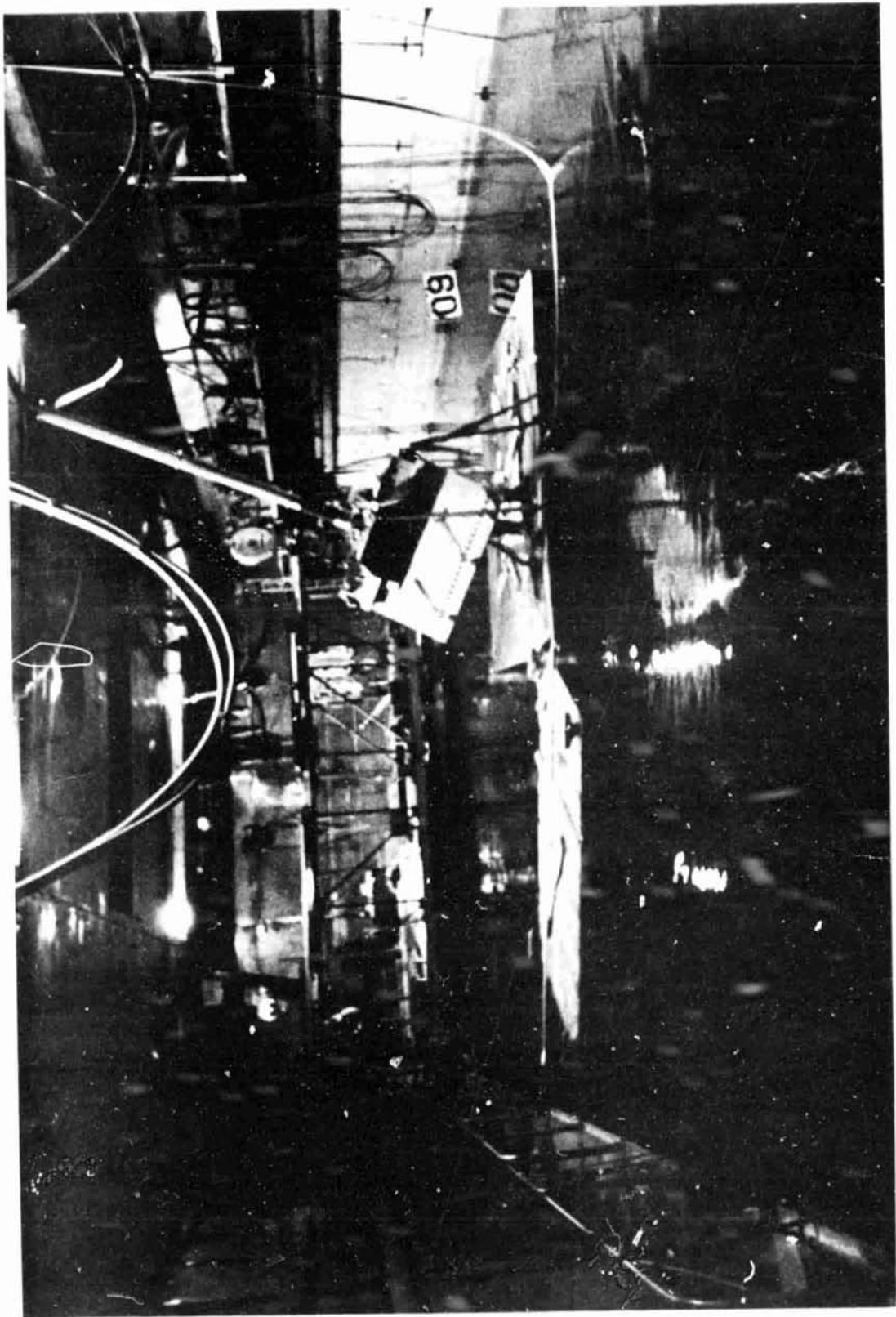


Figure 131 Aft Ring Model
Retrieval Loading on Raft

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MID RING
LOADING INTO GUN
FIGURE 132.



FIGURE 133
MID RING MODEL
LOADING INTO GUN

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604

MID RING MODEL
LOADING INTO GUN

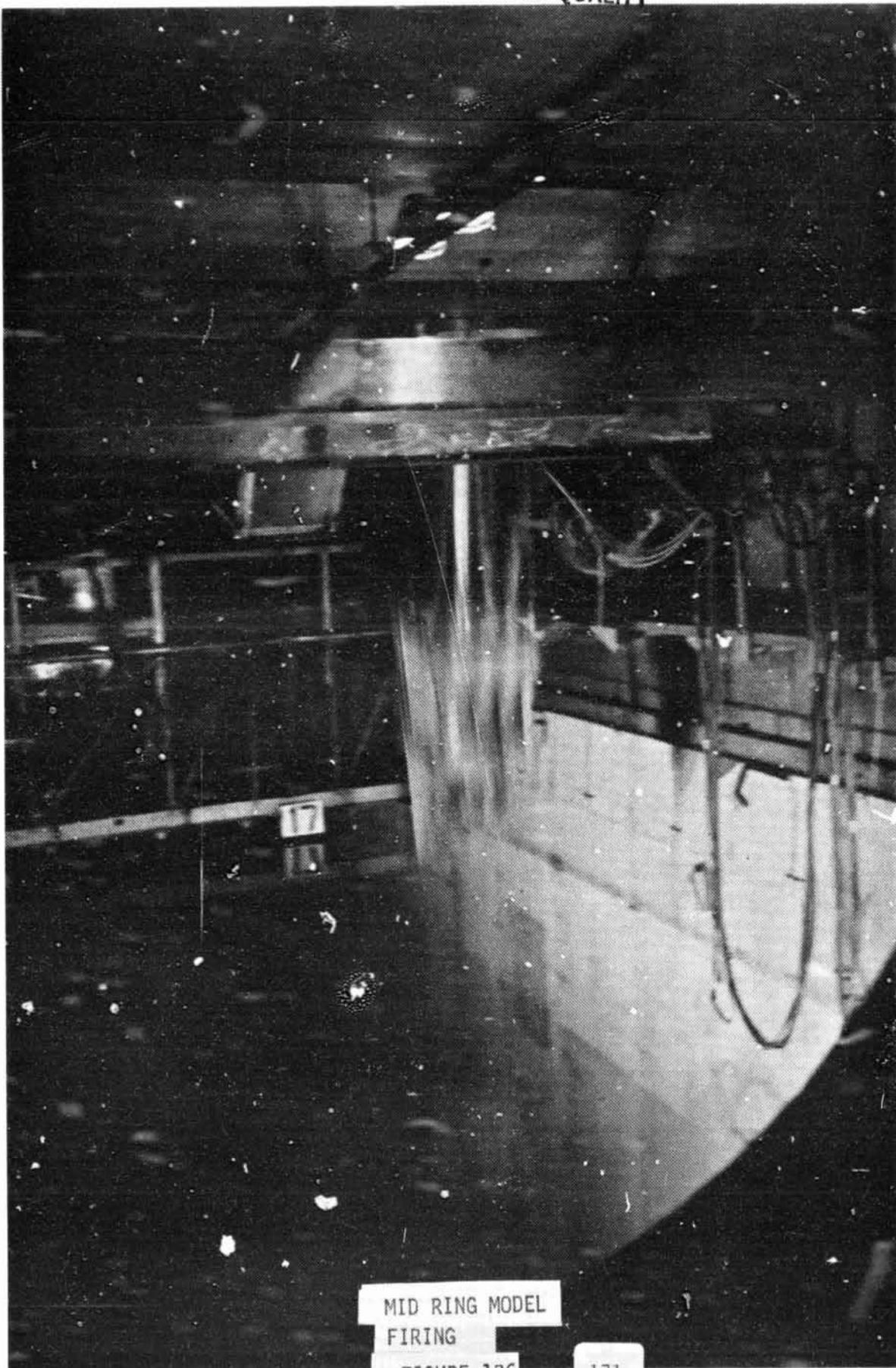
FIGURE 134

169

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(+)
MID RING MODEL
ATTACHING KEVLAR LINE
FIGURE 135.

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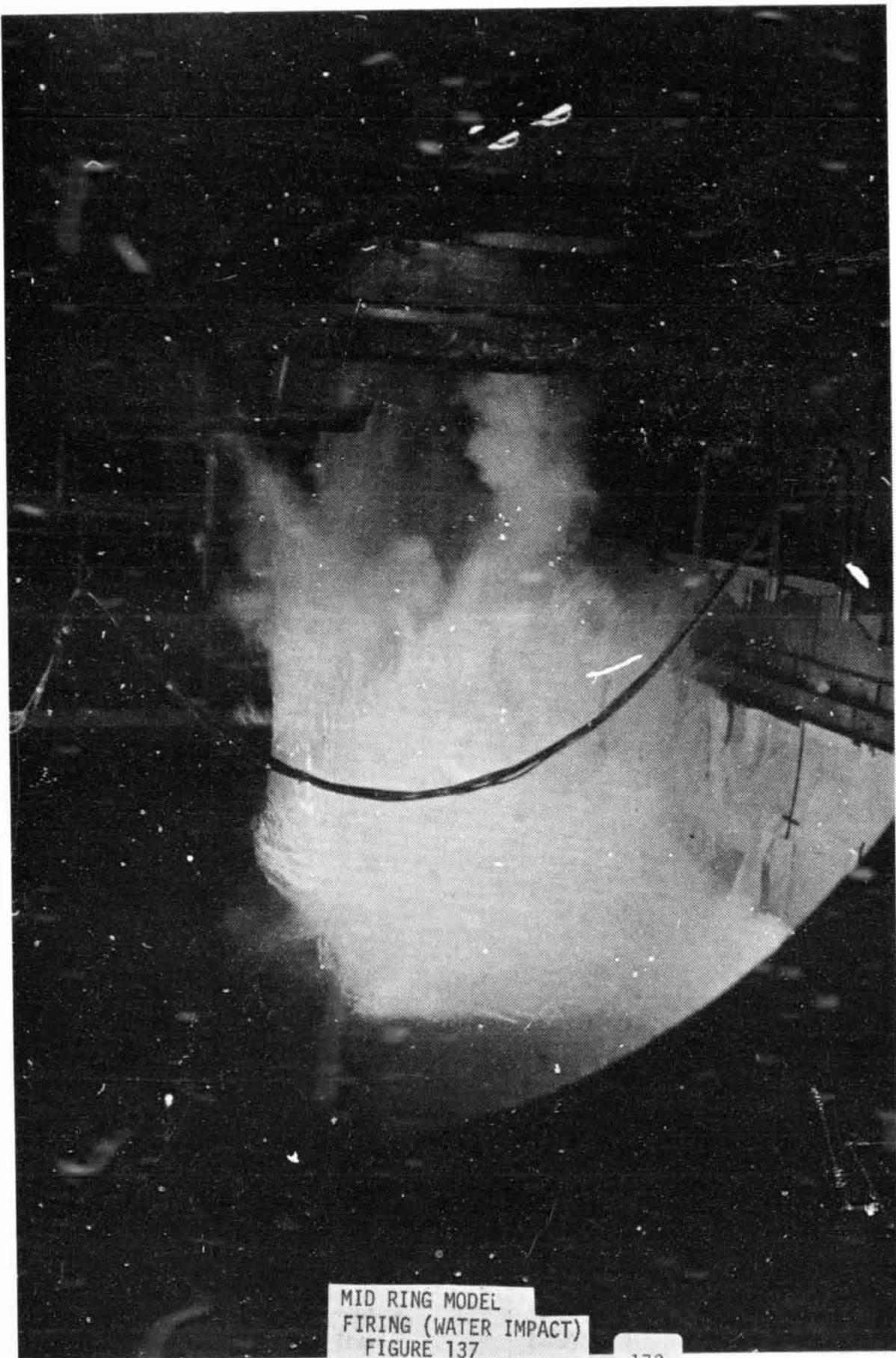


MID RING MODEL
FIRING

FIGURE 136

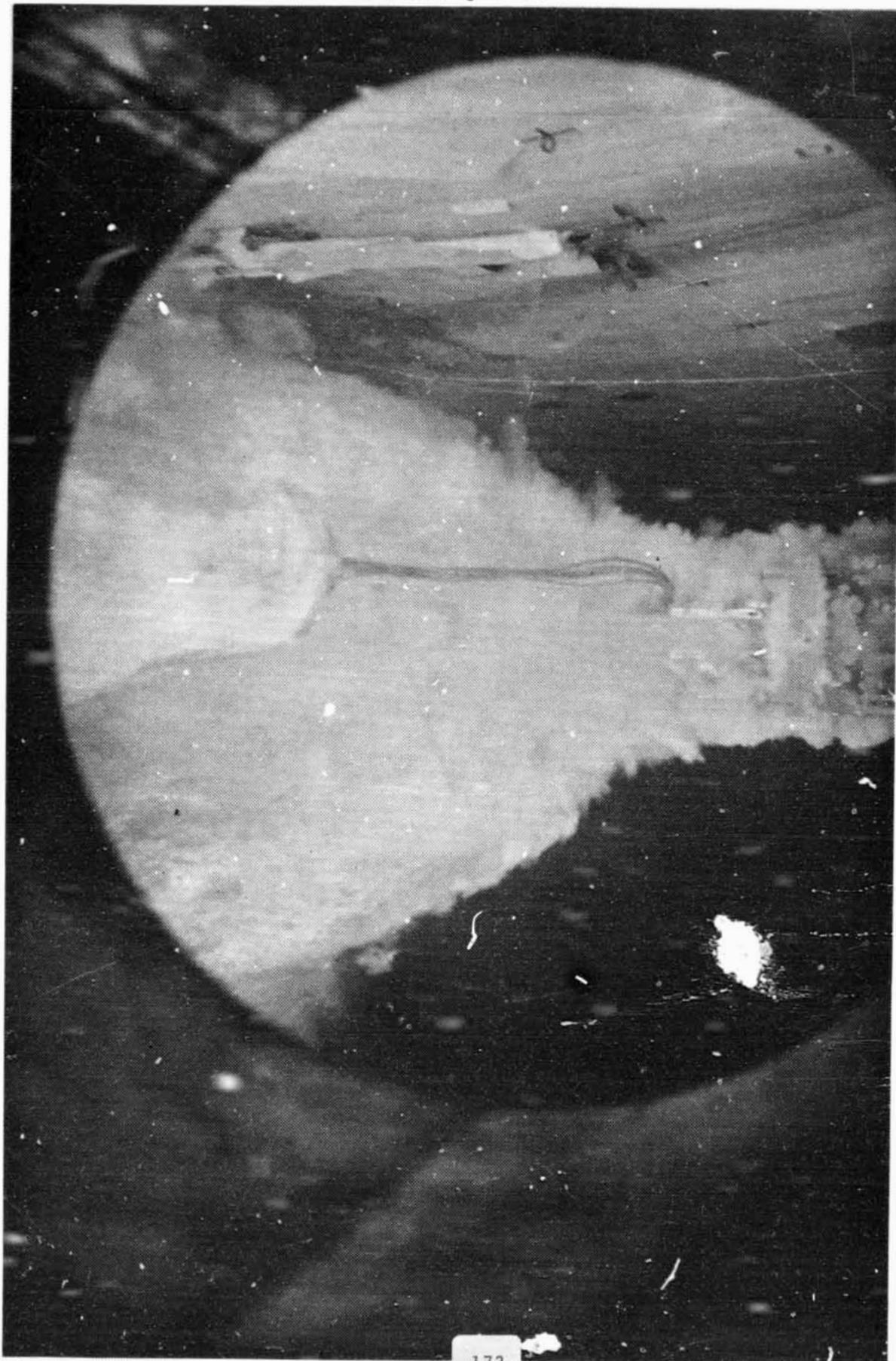
171

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MID RING MODEL
FIRING (WATER IMPACT)
FIGURE 137

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MID RING MODEL
FIRING (UNDERWATER PENETRATION)
FIGURE 138

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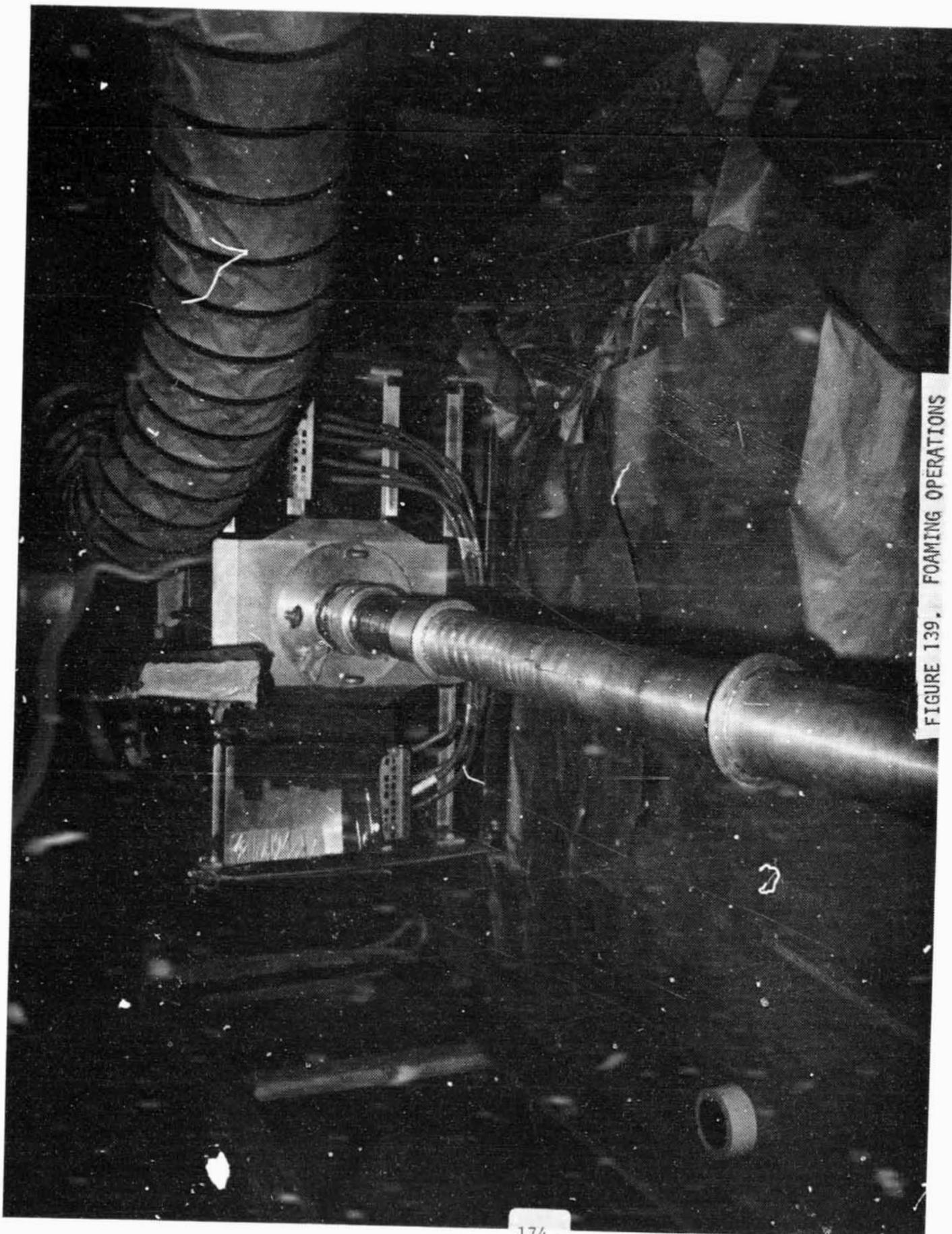
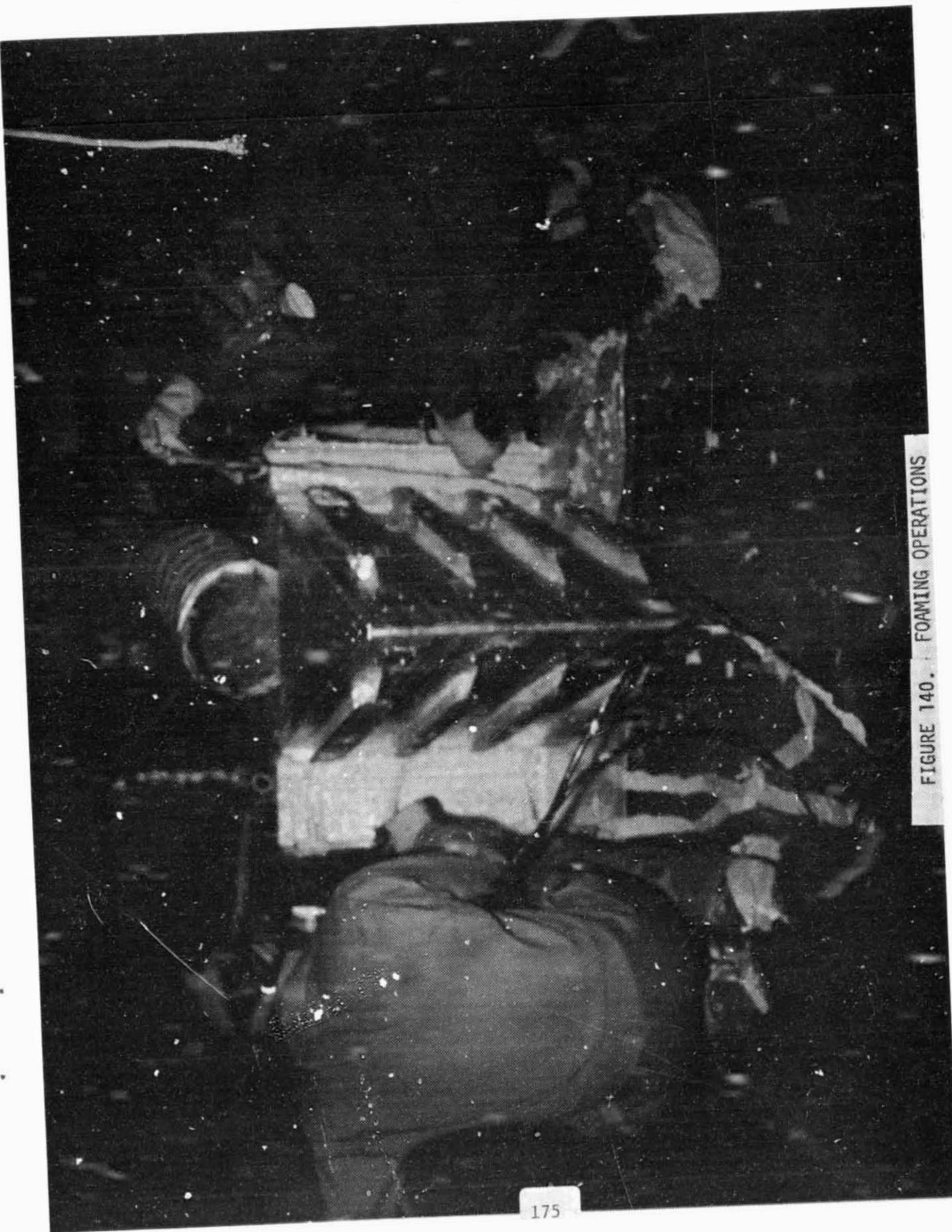


FIGURE 139. FOAMING OPERATIONS

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FIGURE 140. FOAMING OPERATIONS



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FIGURE 141. FOAMING OPERATIONS

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MID RING MODEL
LAYERED FOAM PRIOR TO TEST
FIGURE 142

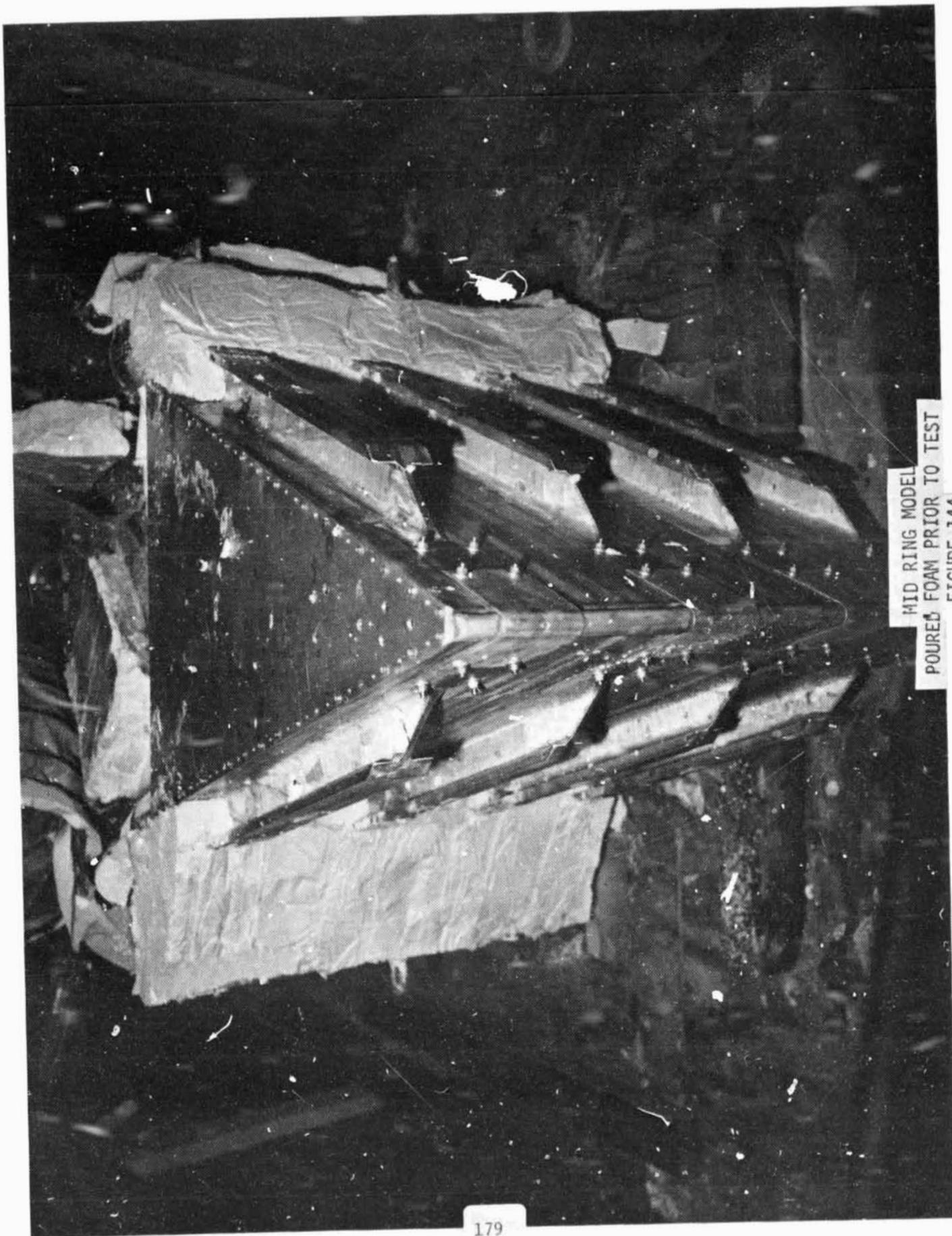
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MID RING MODEL
LAYERED FOAM PRIOR TO TEST

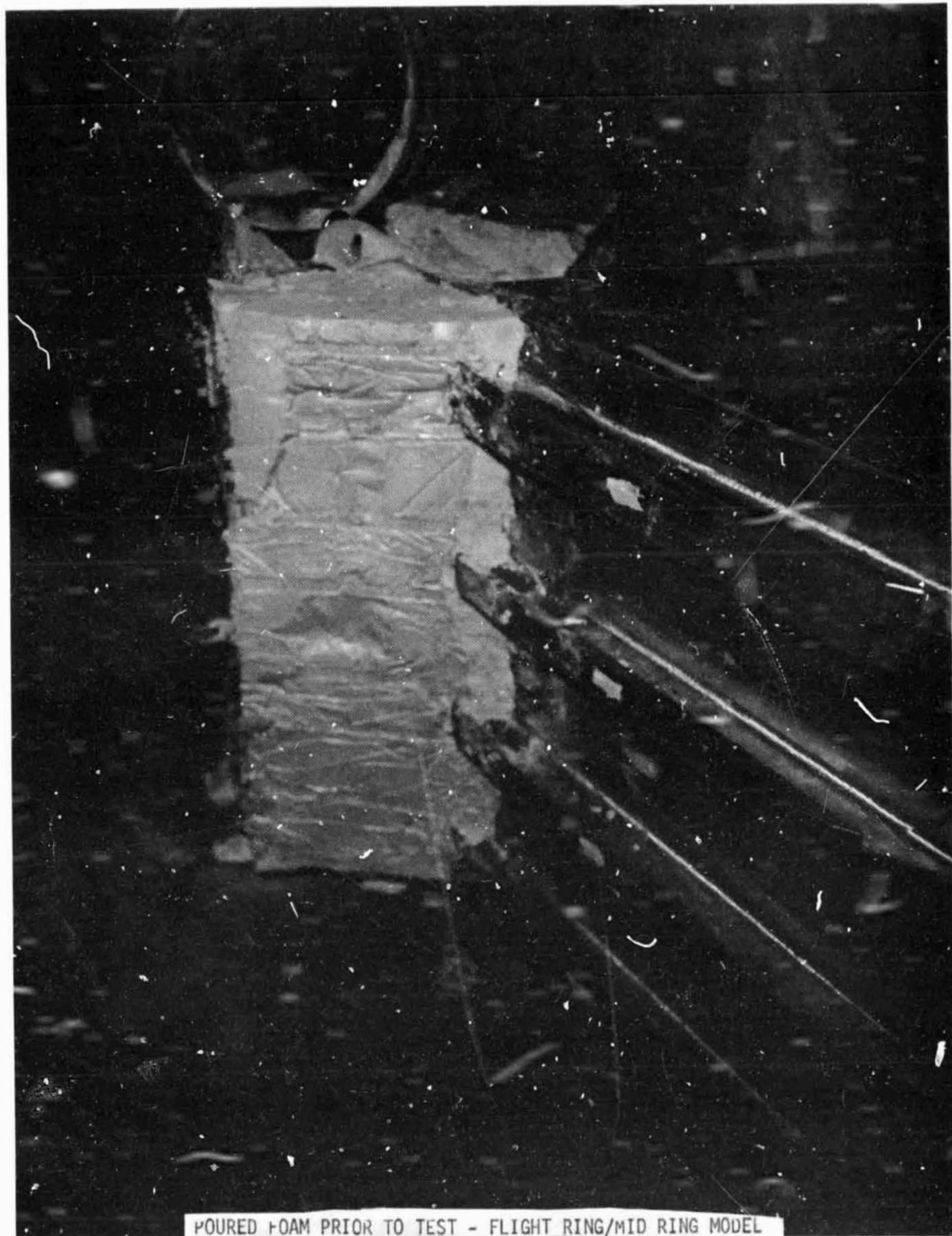
FIGURE 143

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MID RING MODEL
POURED FOAM PRIOR TO TEST
FIGURE 144

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POURED FOAM PRIOR TO TEST - FLIGHT RING/MID RING MODEL
FIGURE 145 180

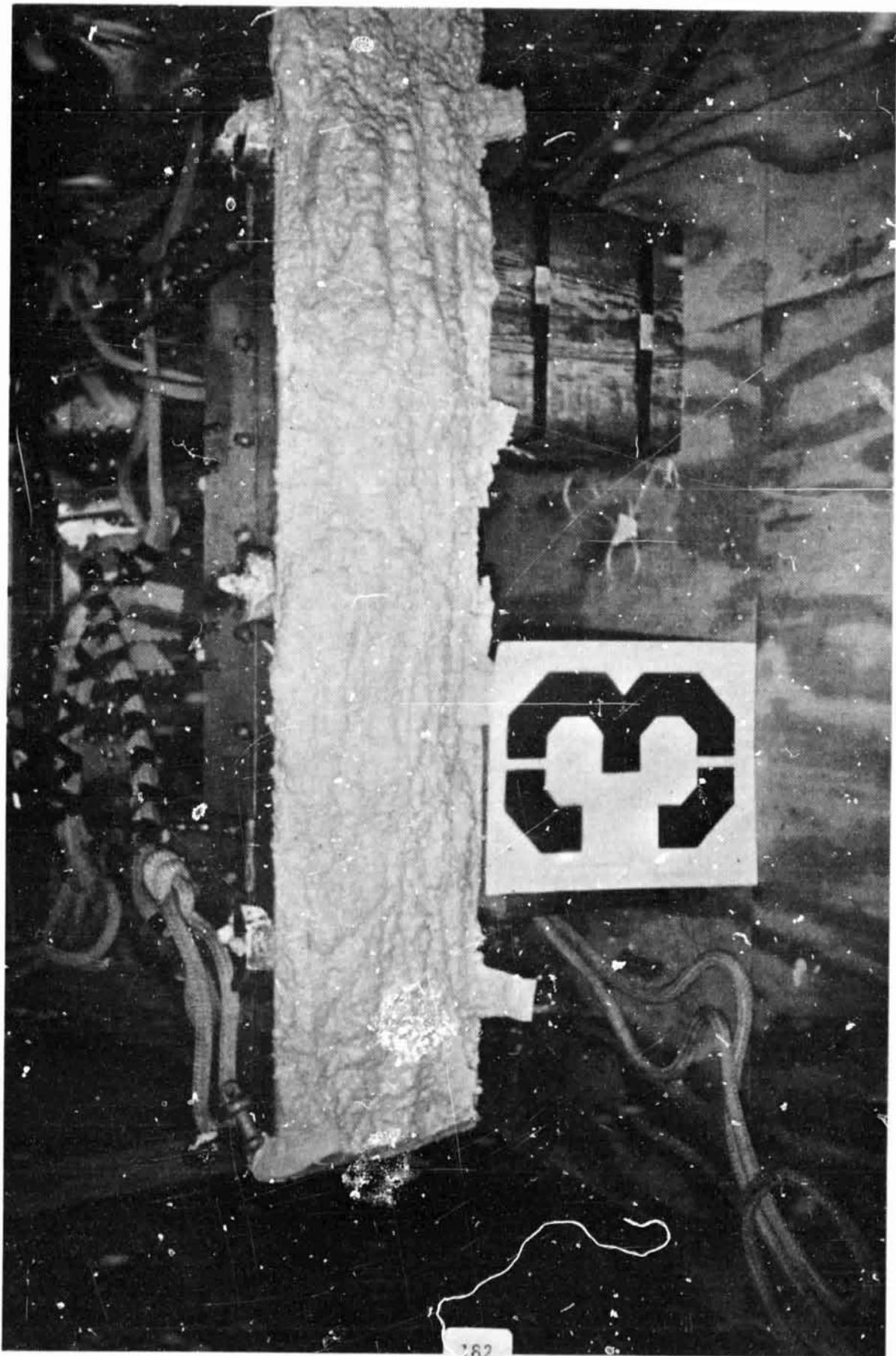
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POURED FOAM PRIOR TO TEST - NEW RING/MID RING MODEL

FIGURE 146

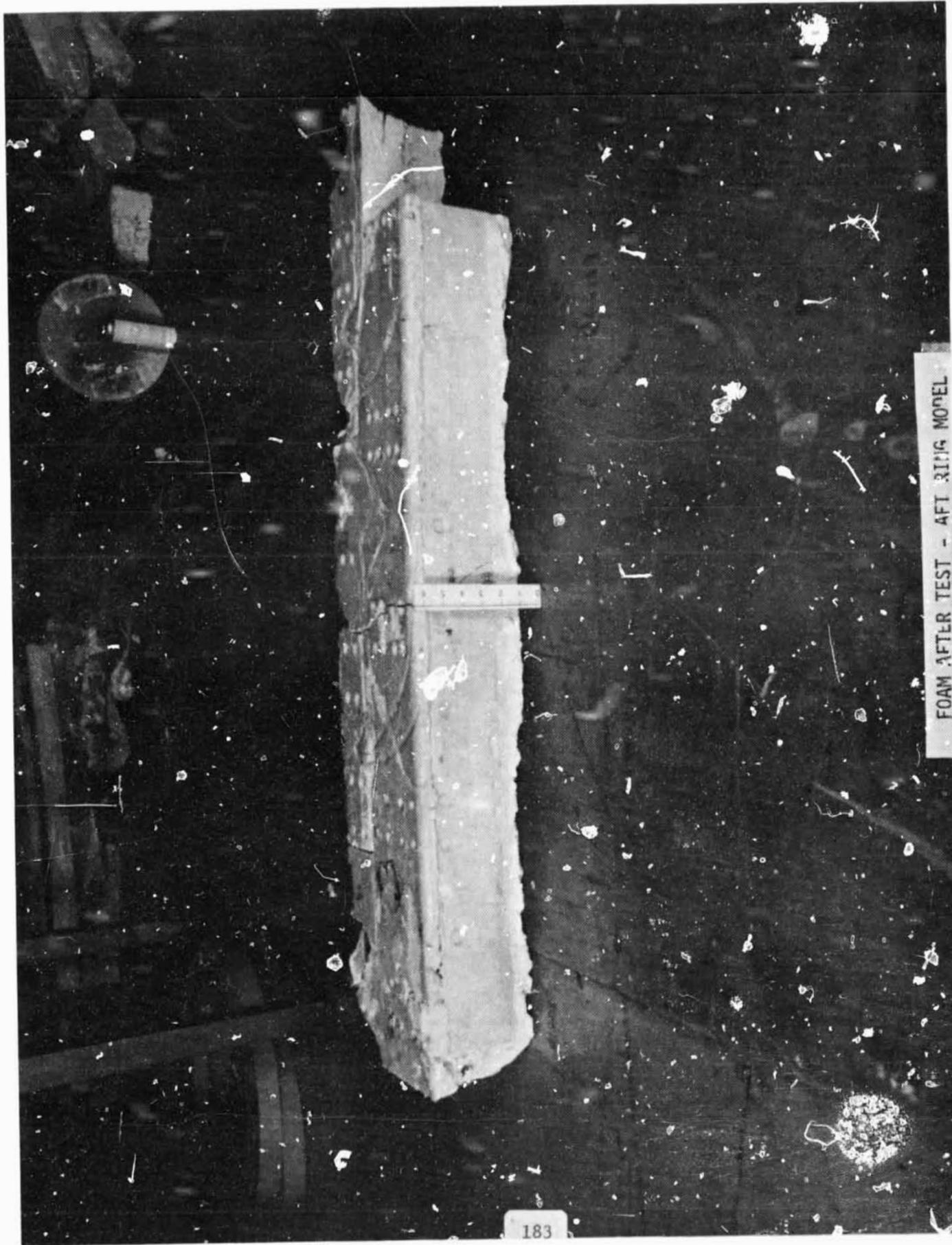
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282

FOAM AFTER TEST - AFT RING MODEL
FIGURE 147

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FOAM AFTER TEST - AFT 311G MODEL
FIGURE 148

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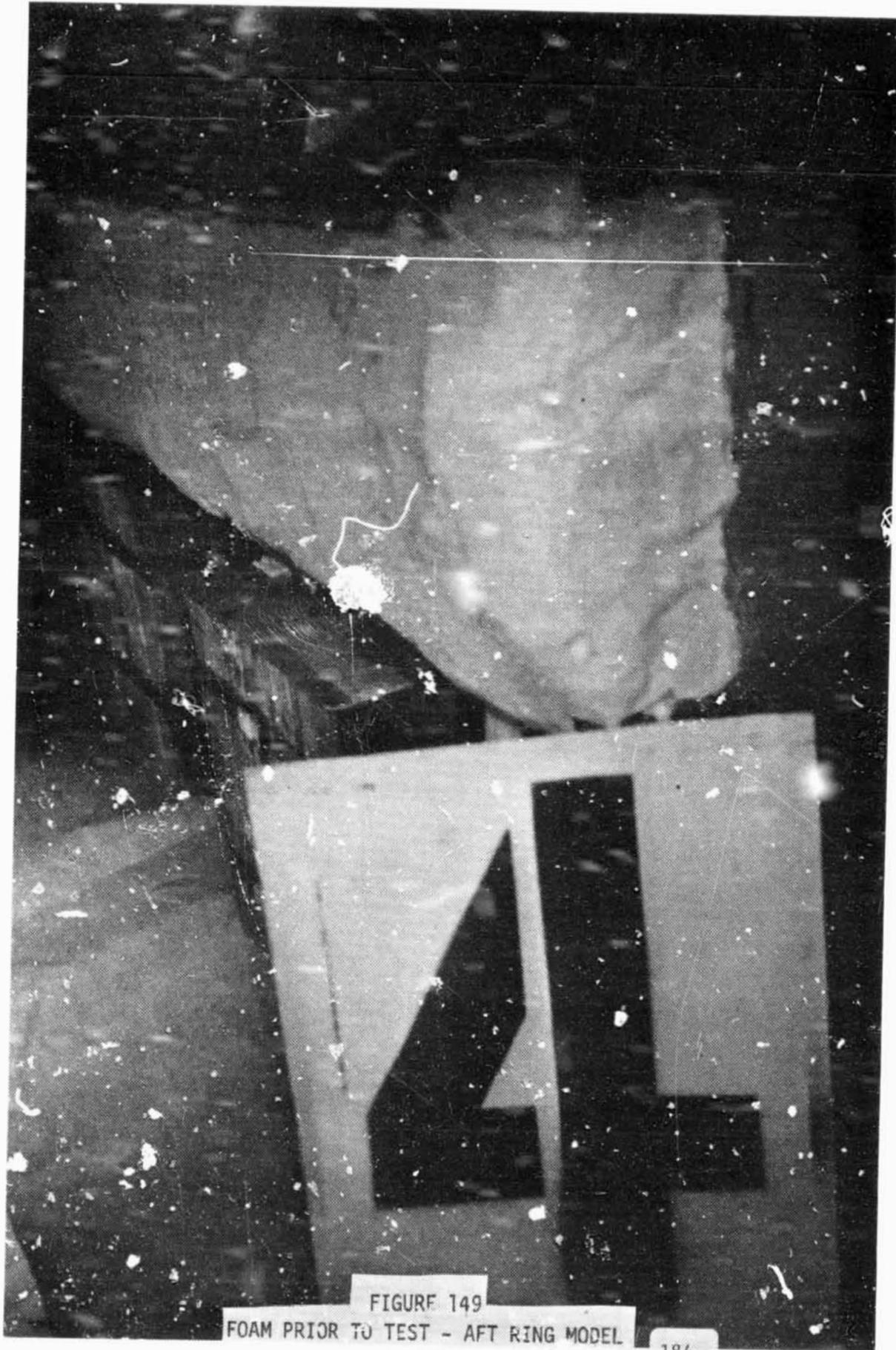


FIGURE 149
FOAM PRIOR TO TEST - AFT RING MODEL

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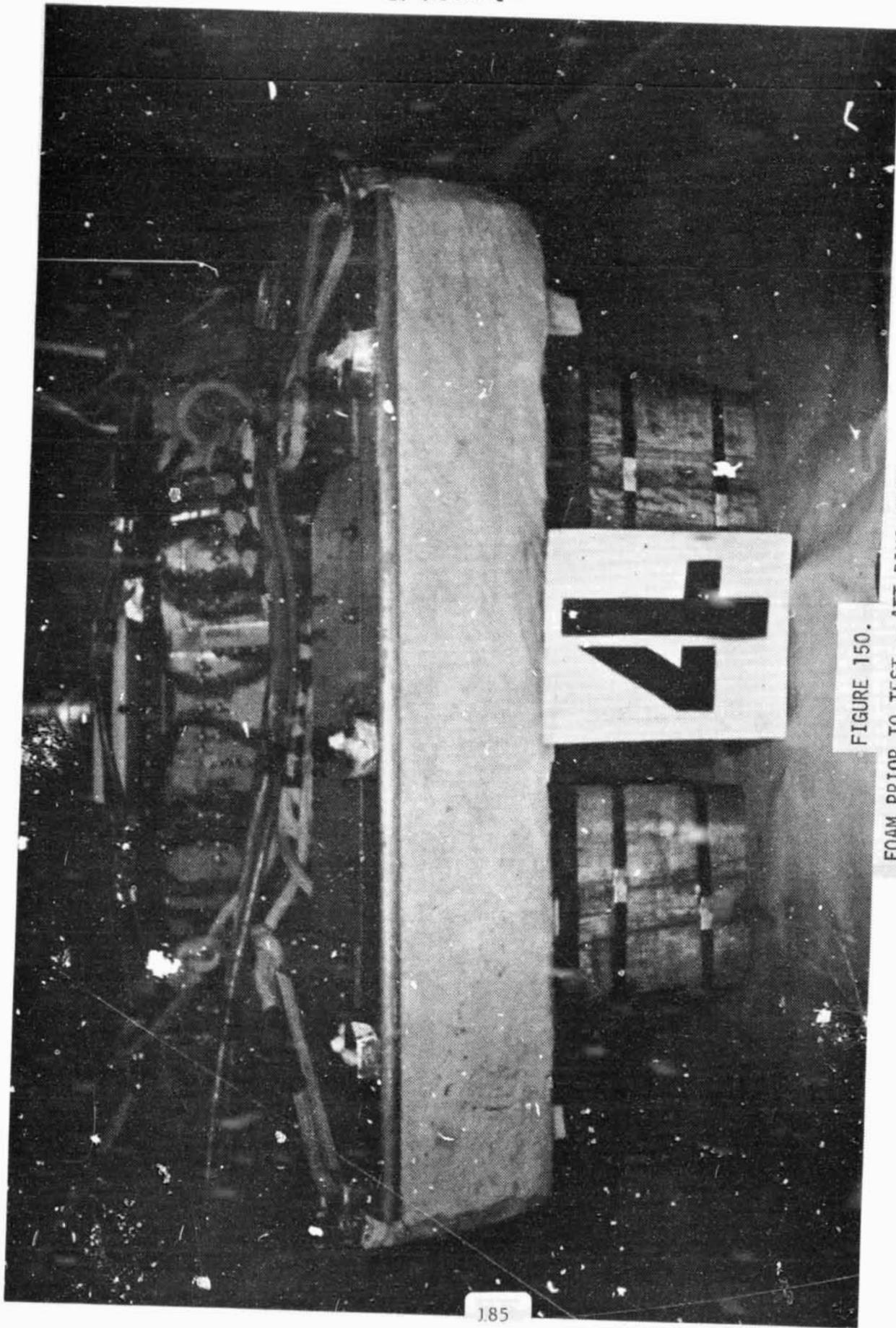


FIGURE 150.
FOAM PRIOR TO TEST - AFT RING MODEL

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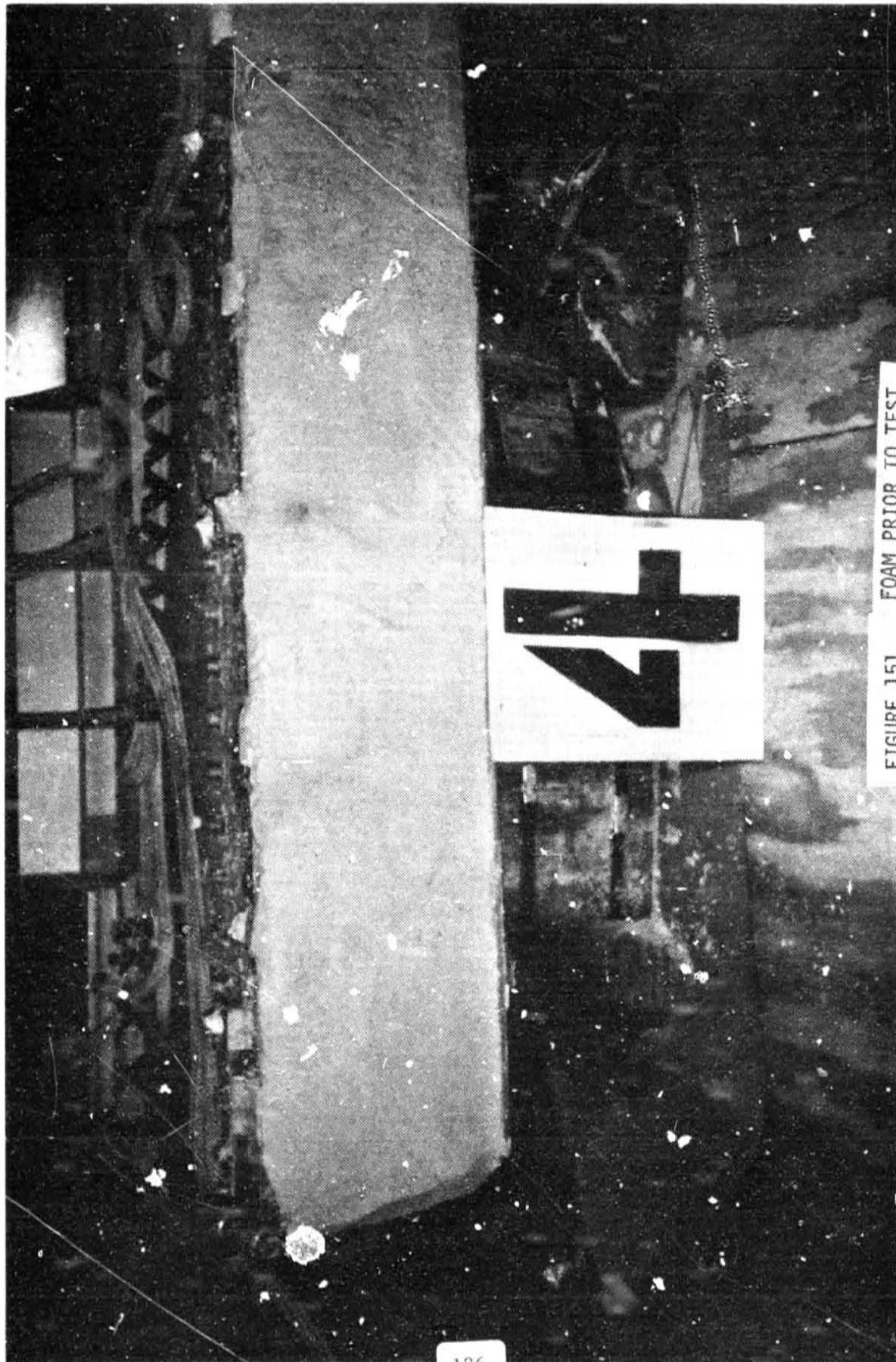


FIGURE 151. FOAM PRIOR TO TEST

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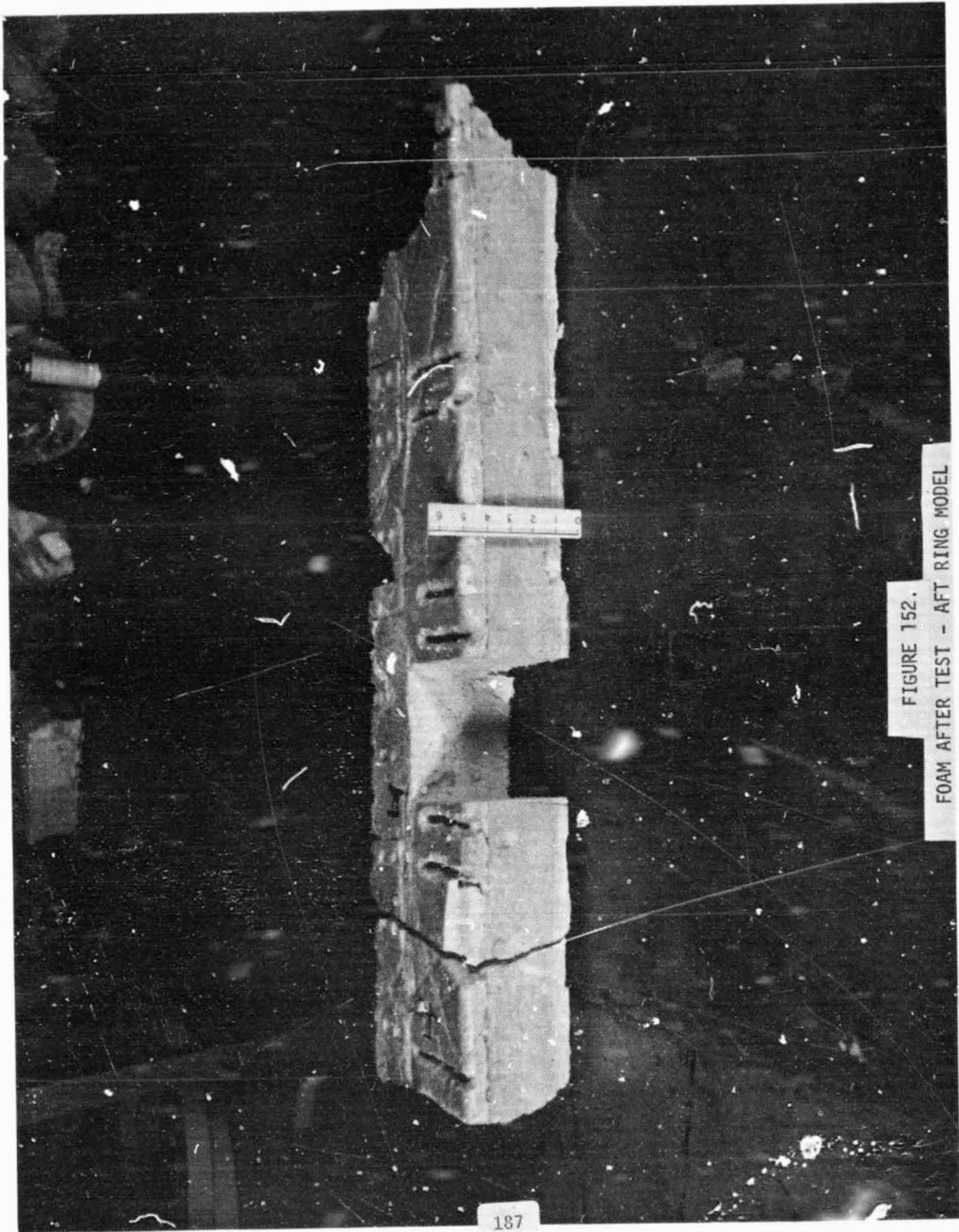


FIGURE 152.
FOAM AFTER TEST - AFT RING MODEL

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FIGURE 153. FOAM PRIOR TO TEST - AFT RING MODEL

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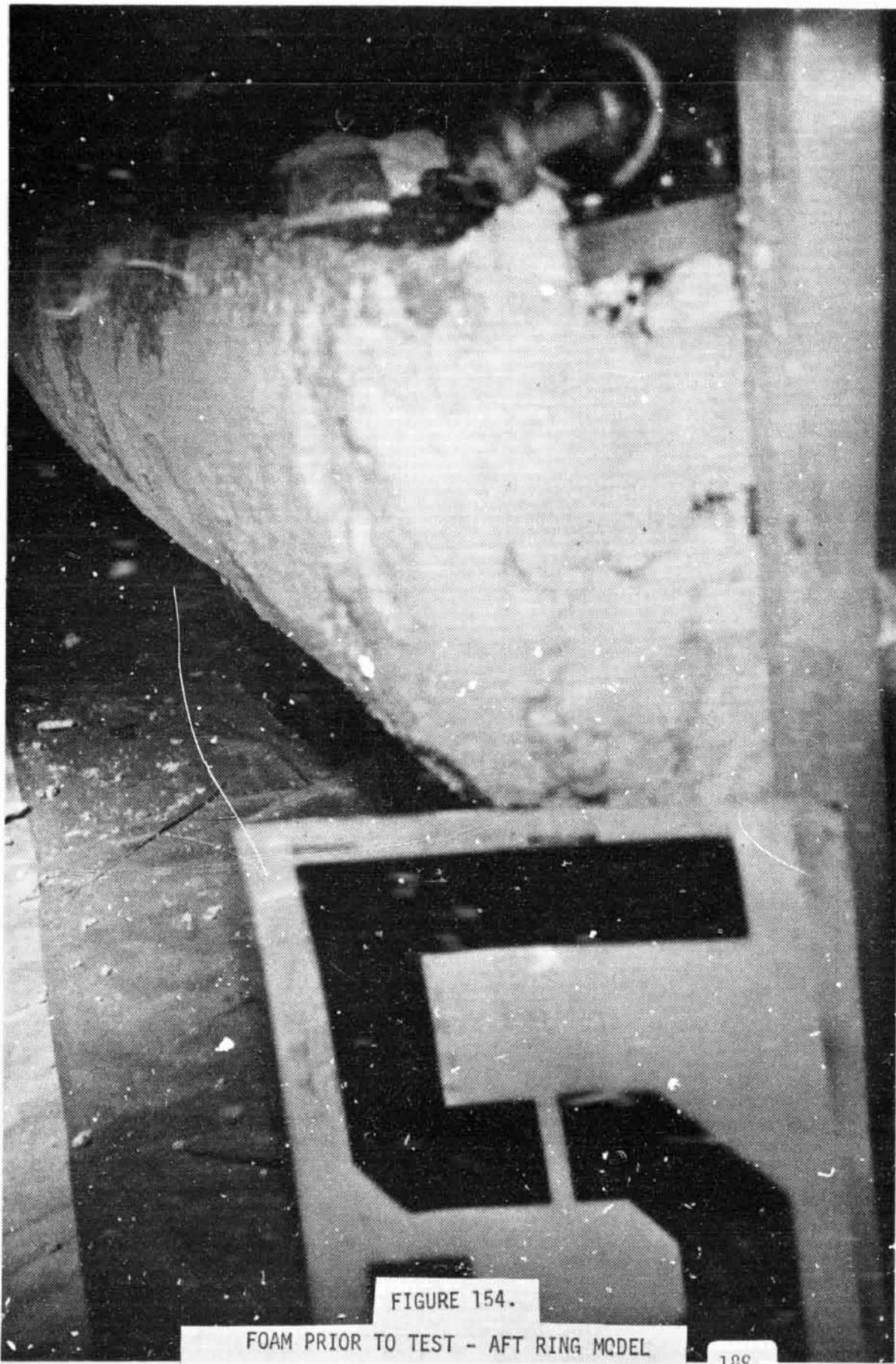


FIGURE 154.

FOAM PRIOR TO TEST - AFT RING MODEL

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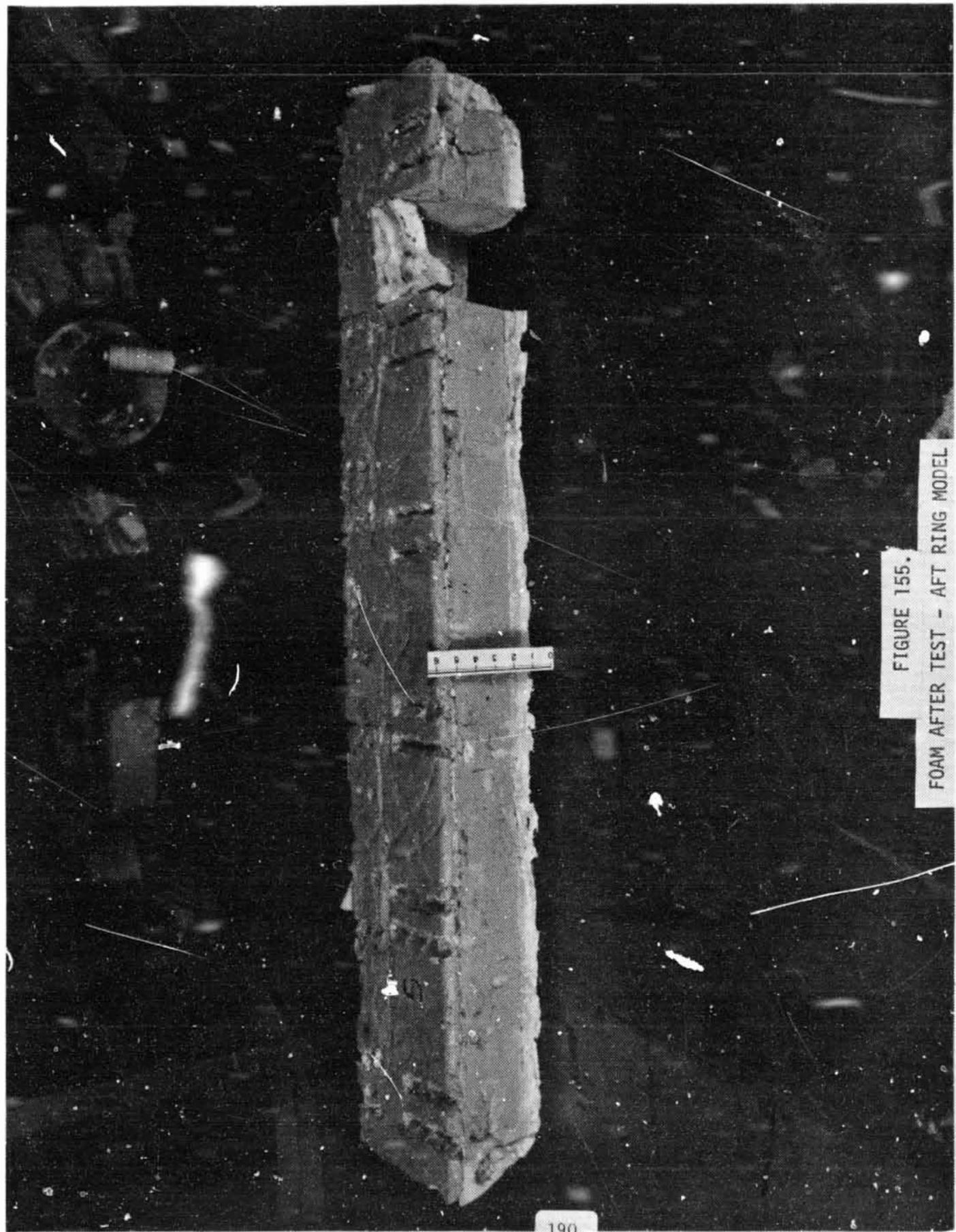


FIGURE 155.
FOAM AFTER TEST - AFT RING MODEL

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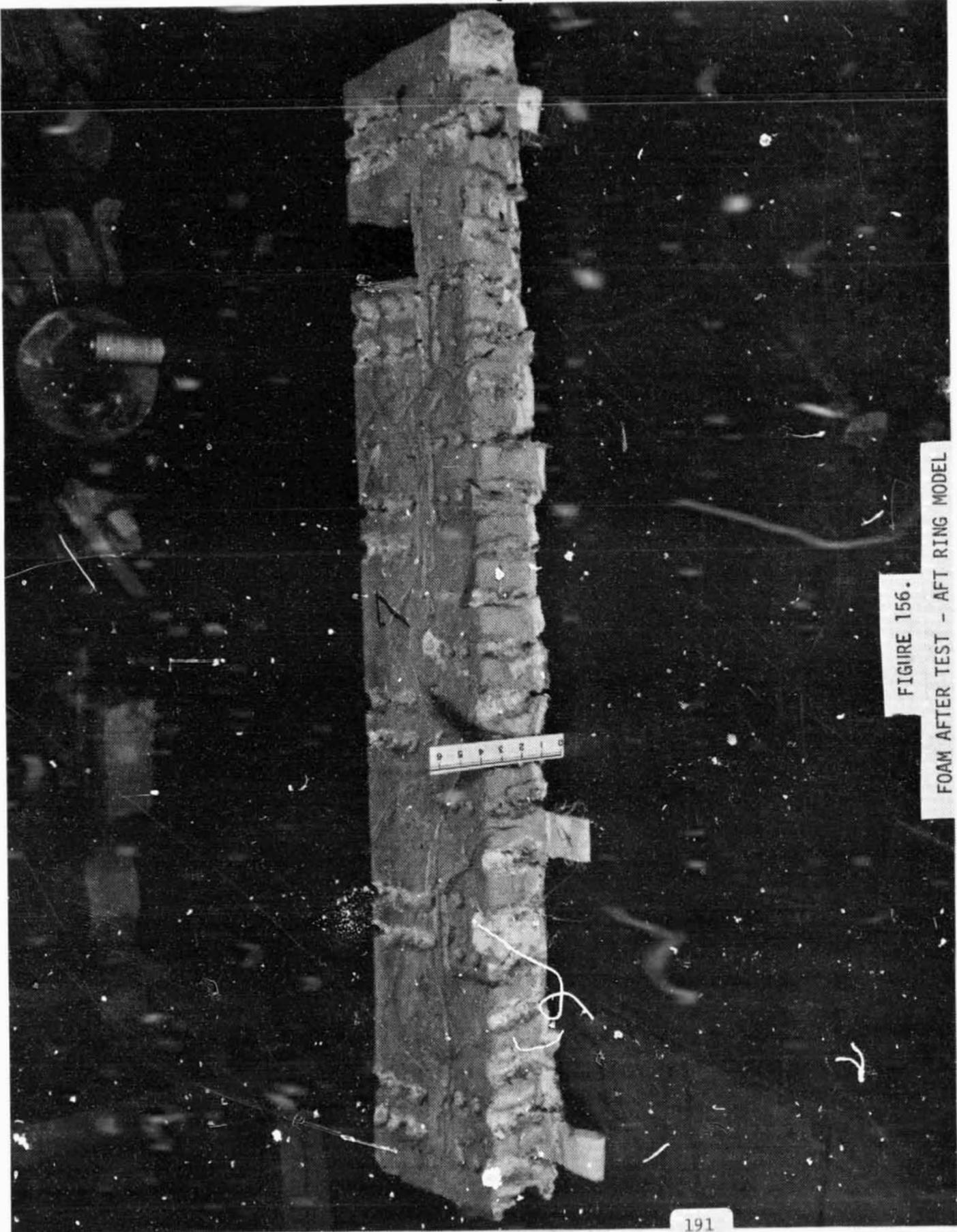


FIGURE 156.
FOAM AFTER TEST - AFT RING MODEL

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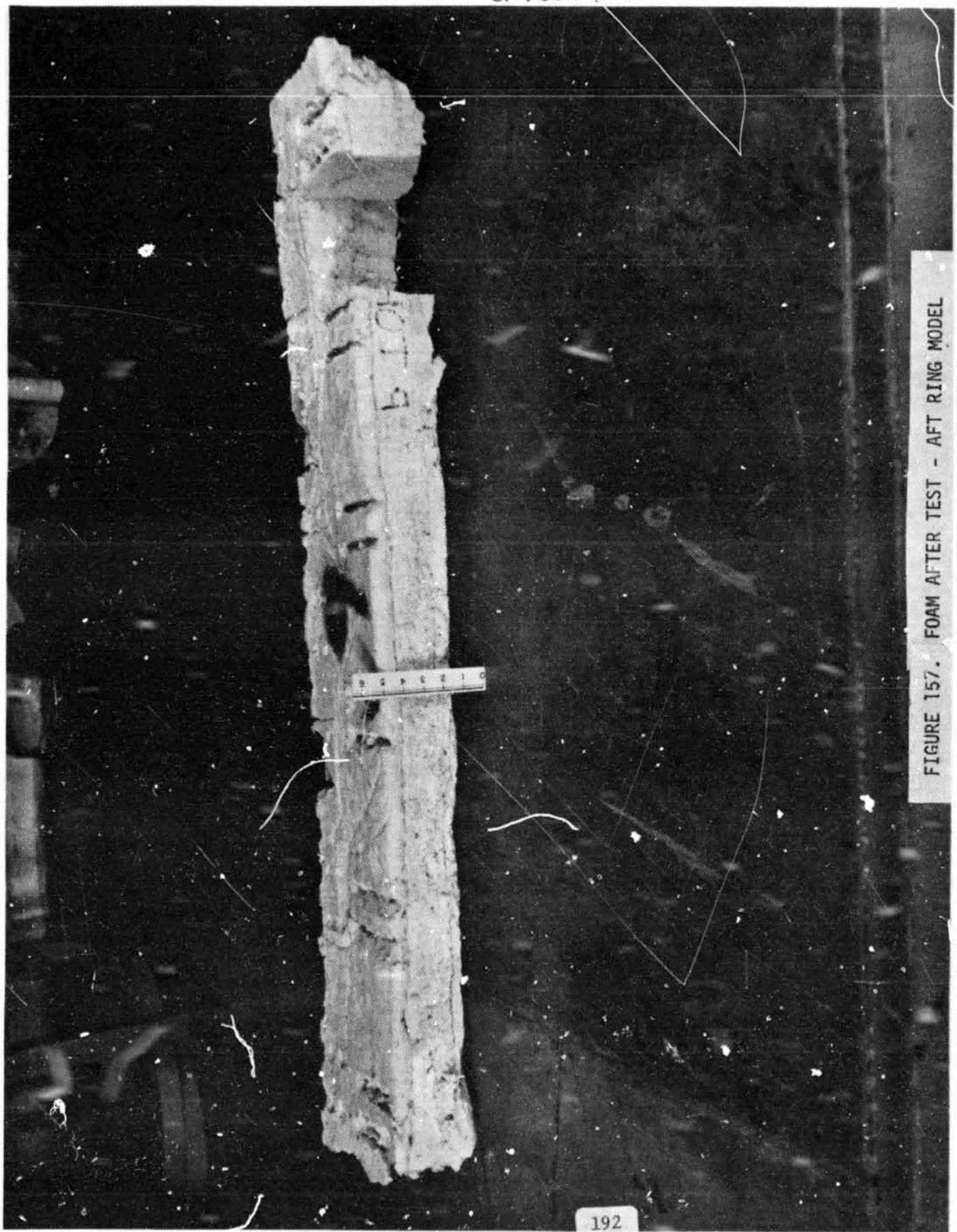


FIGURE 157. FOAM AFTER TEST - AFT RING MODEL

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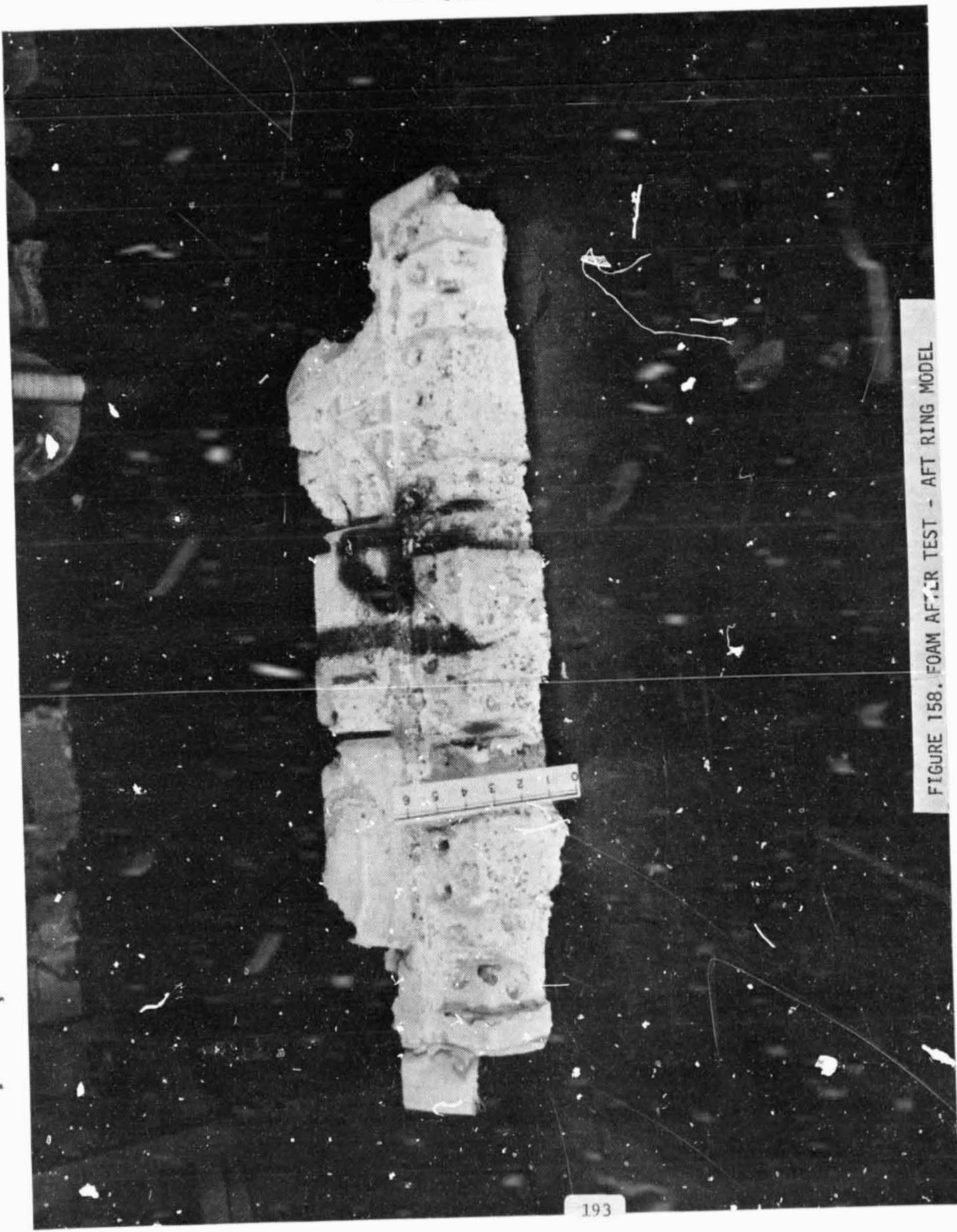


FIGURE 158. FOAM AFT.R TEST - AFT RING MODEL

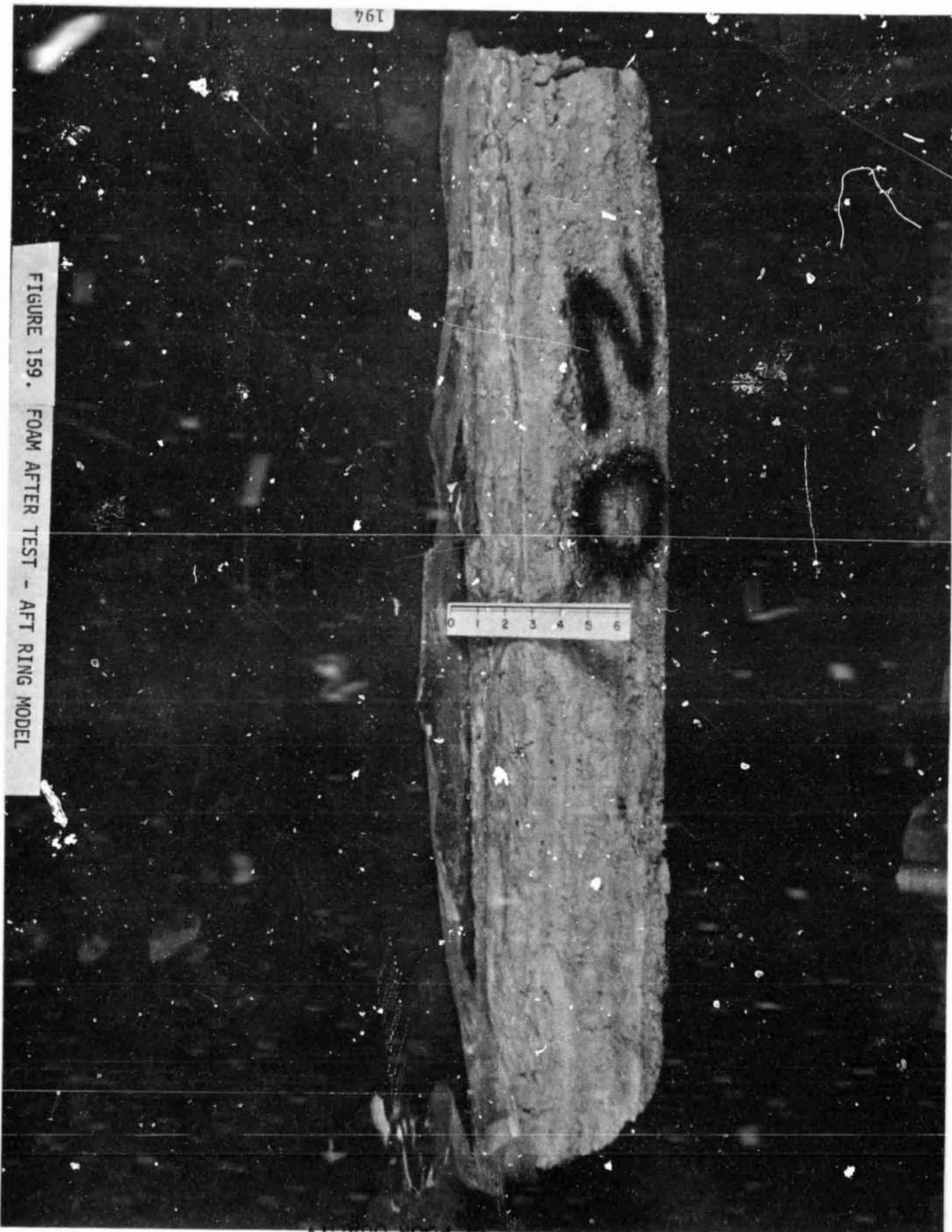


FIGURE 159. FOAM AFTER TEST - AFT RING MODEL

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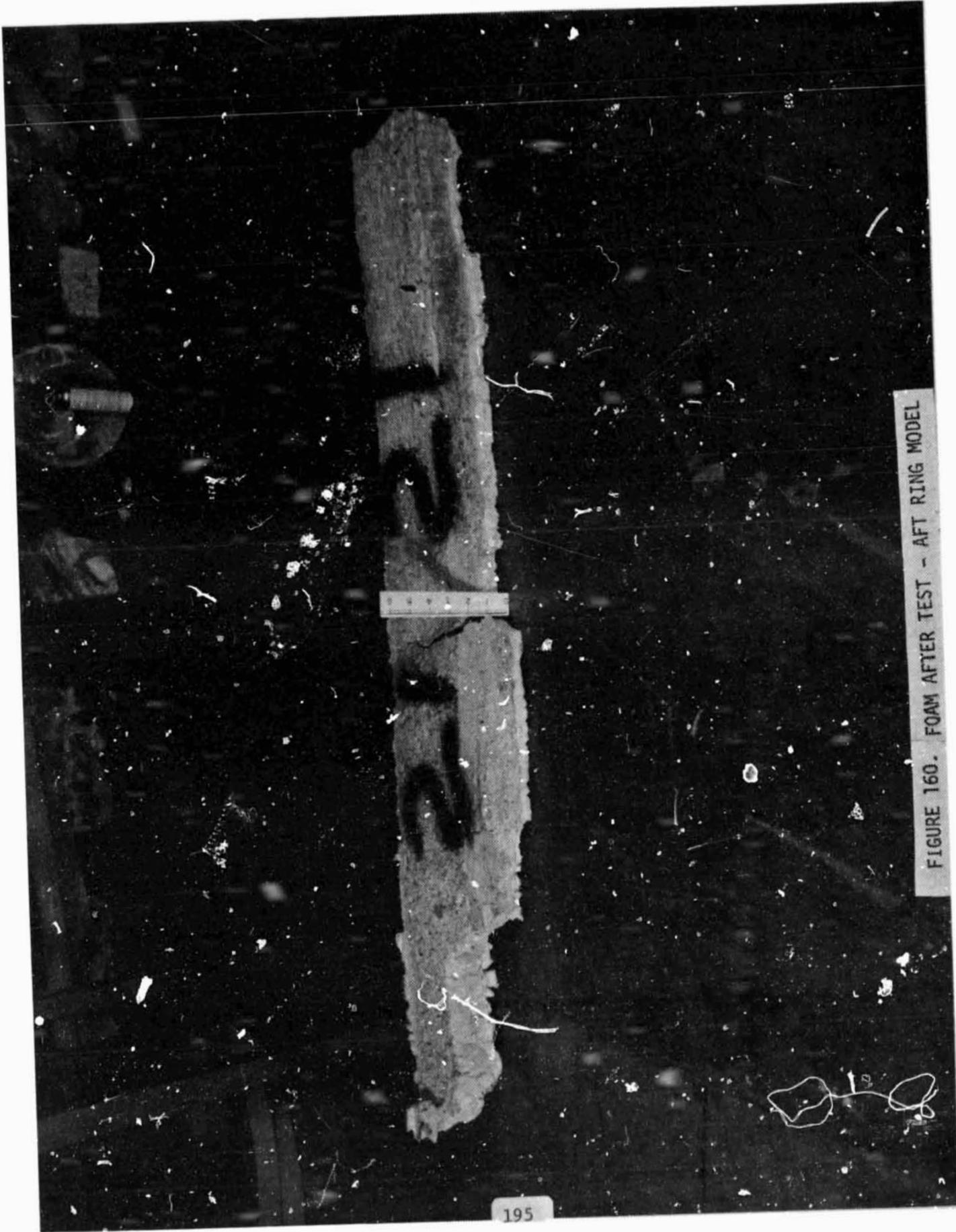


FIGURE 160. FOAM AFTER TEST - AFT RING MODEL

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FIGURE 161.

FOAM AFTER TEST - FLIGHT RING/MID RING MODEL

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FIGURE 162. FOAM PRIOR TO TEST - AFT RING MODEL



FIGURE 163. FOAM AFTER TEST - AFT RING MODEL

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FIGURE 164.
FOAM AFTER TEST - AFT RING MODEL

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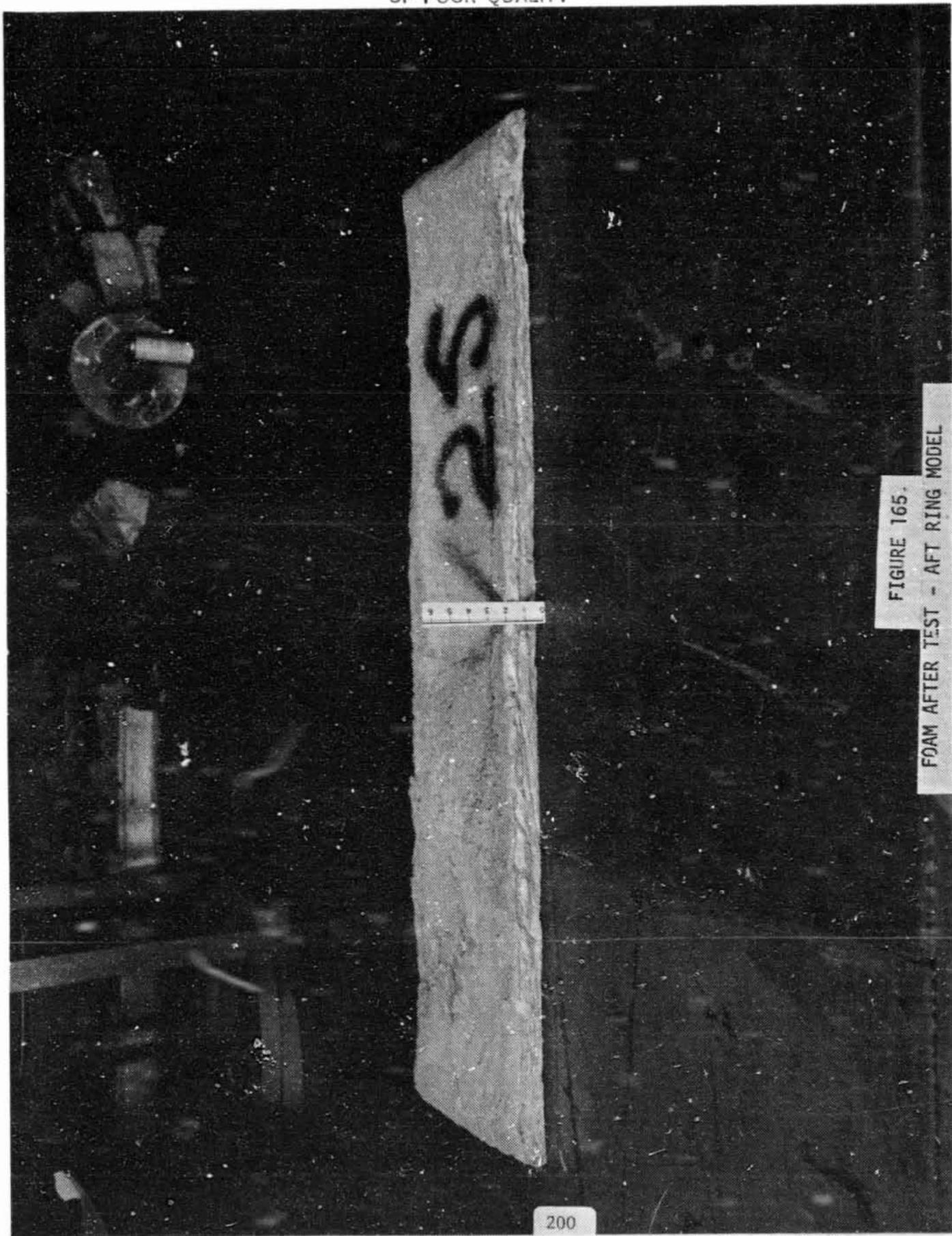


FIGURE 165.
FOAM AFTER TEST - AFT RING MODEL

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FIGURE 166.

FOAM PRIOR TO TEST - AFT RING MODEL

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FIGURE 167. FOAM PRIOR TO TEST - AFT RING MODEL

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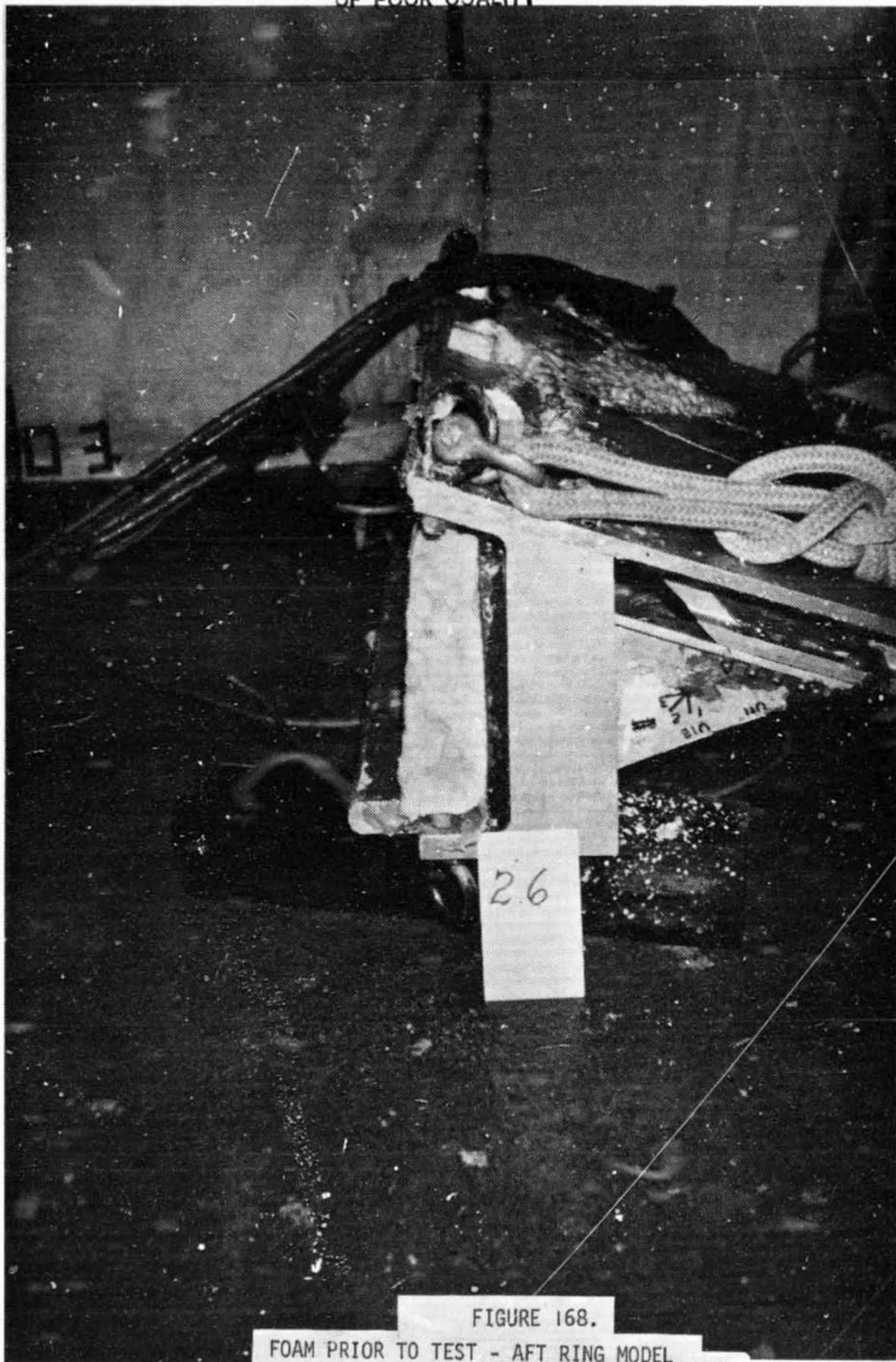


FIGURE 168.
FOAM PRIOR TO TEST - AFT RING MODEL

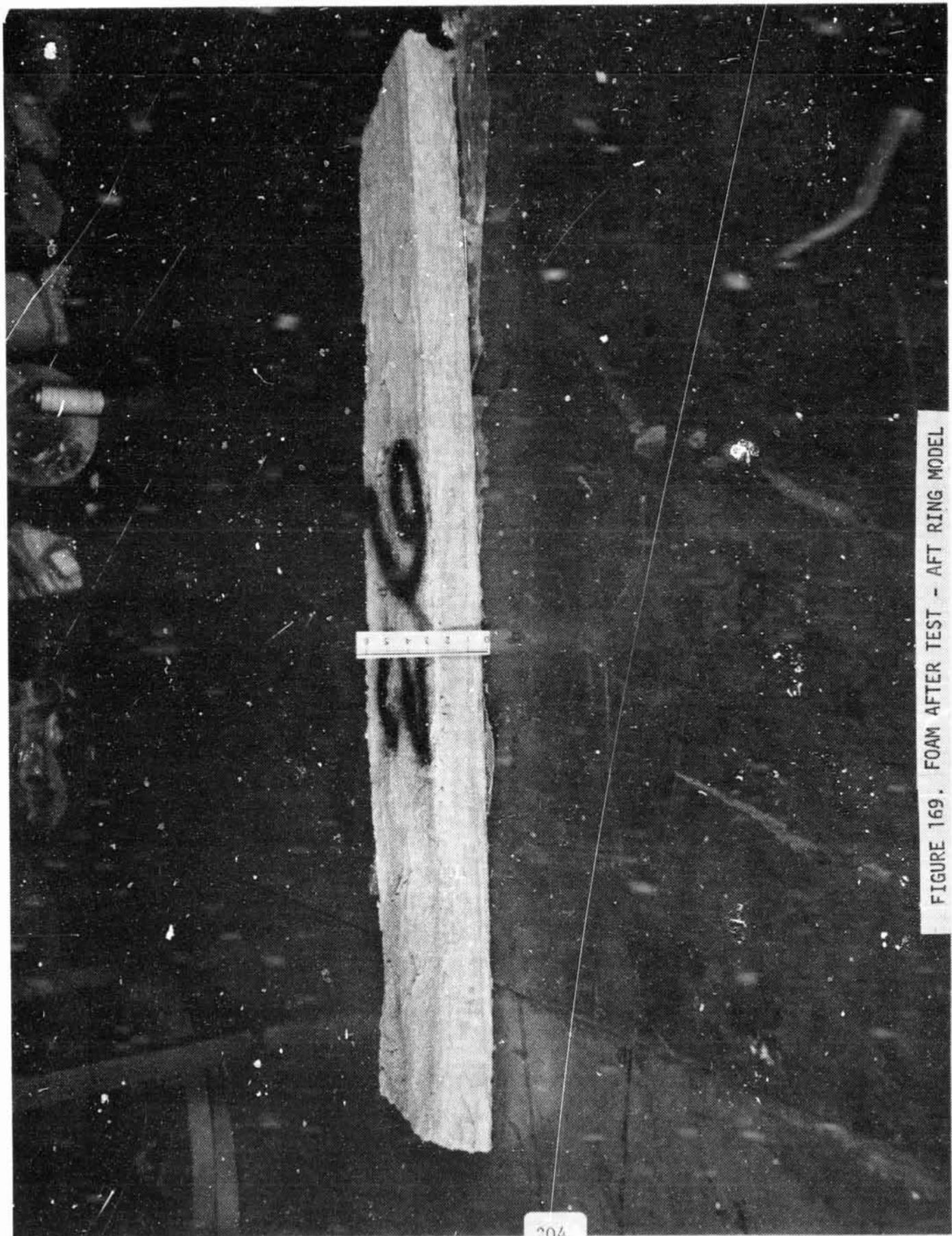


FIGURE 169. FOAM AFTER TEST - AFT RING MODEL

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FIGURE 170.
FOAM AFTER TEST - FLIGHT RING/MID RING MODEL

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FIGURE 171. FOAM AFTER TEST - AFT RING MODEL

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FIGURE 172.
FOAM AFTER TEST - AFT RING MODEL

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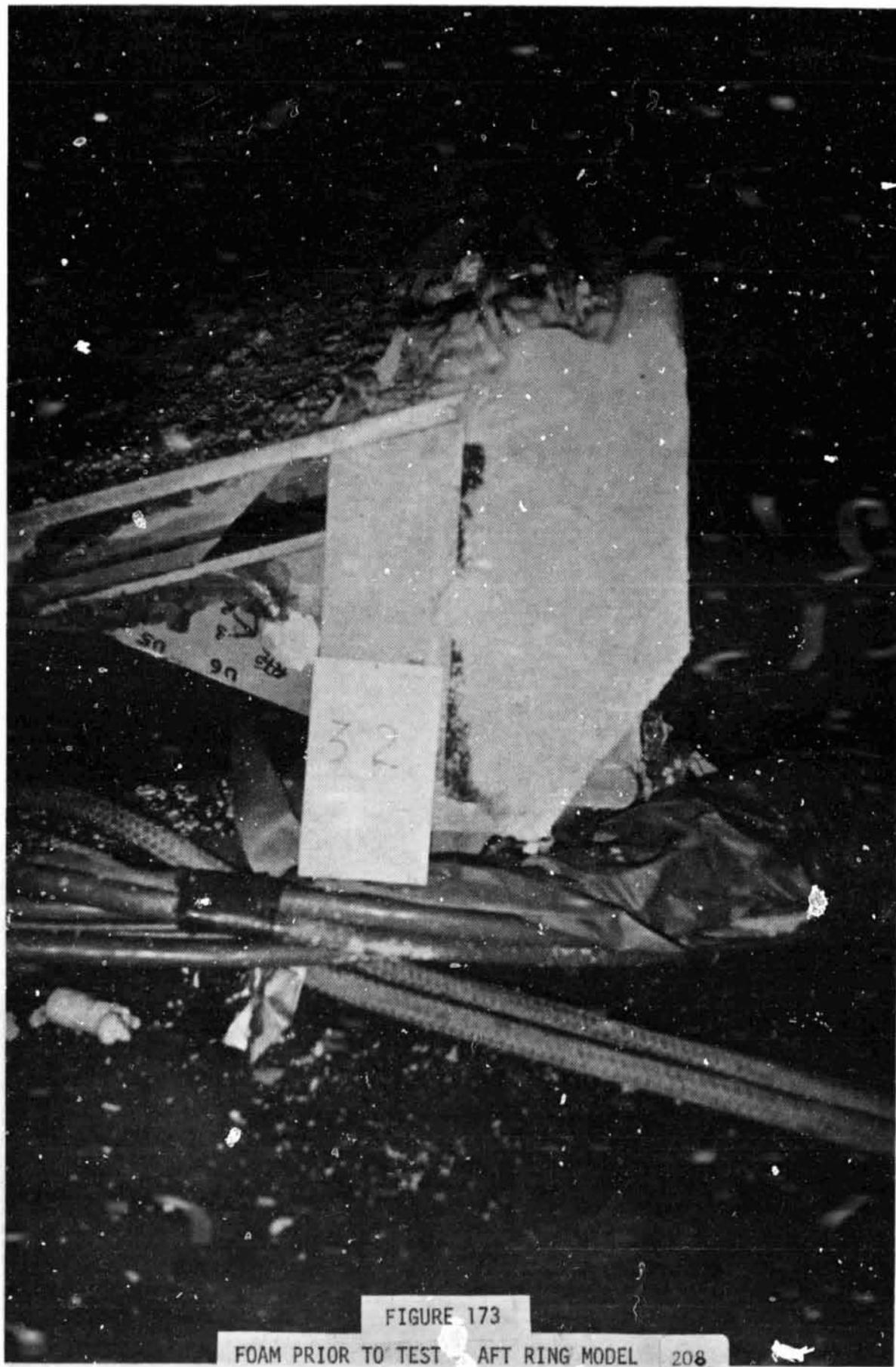


FIGURE 173

FOAM PRIOR TO TEST - AFT RING MODEL

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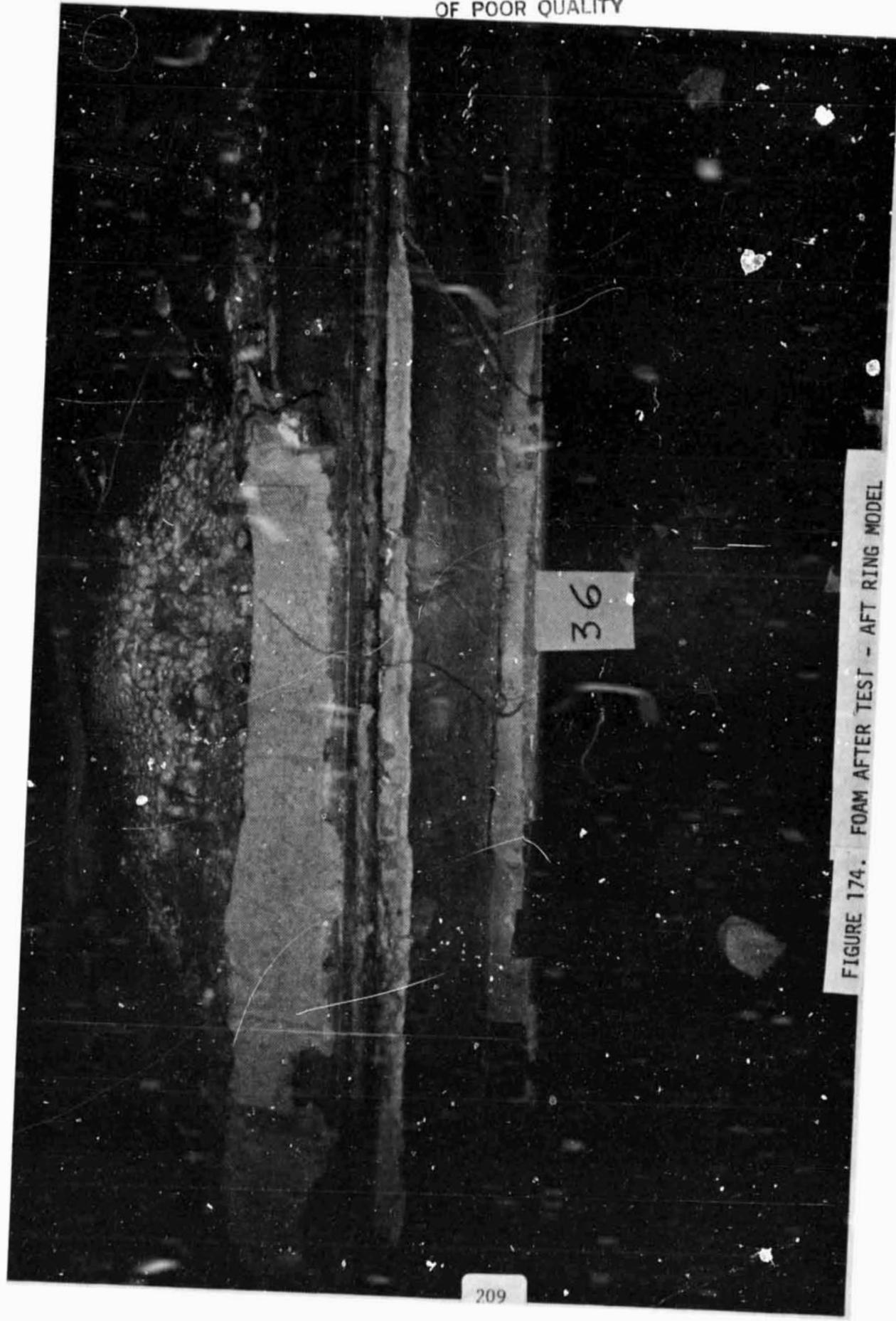


FIGURE 174. FOAM AFTER TEST - AFT RING MODEL

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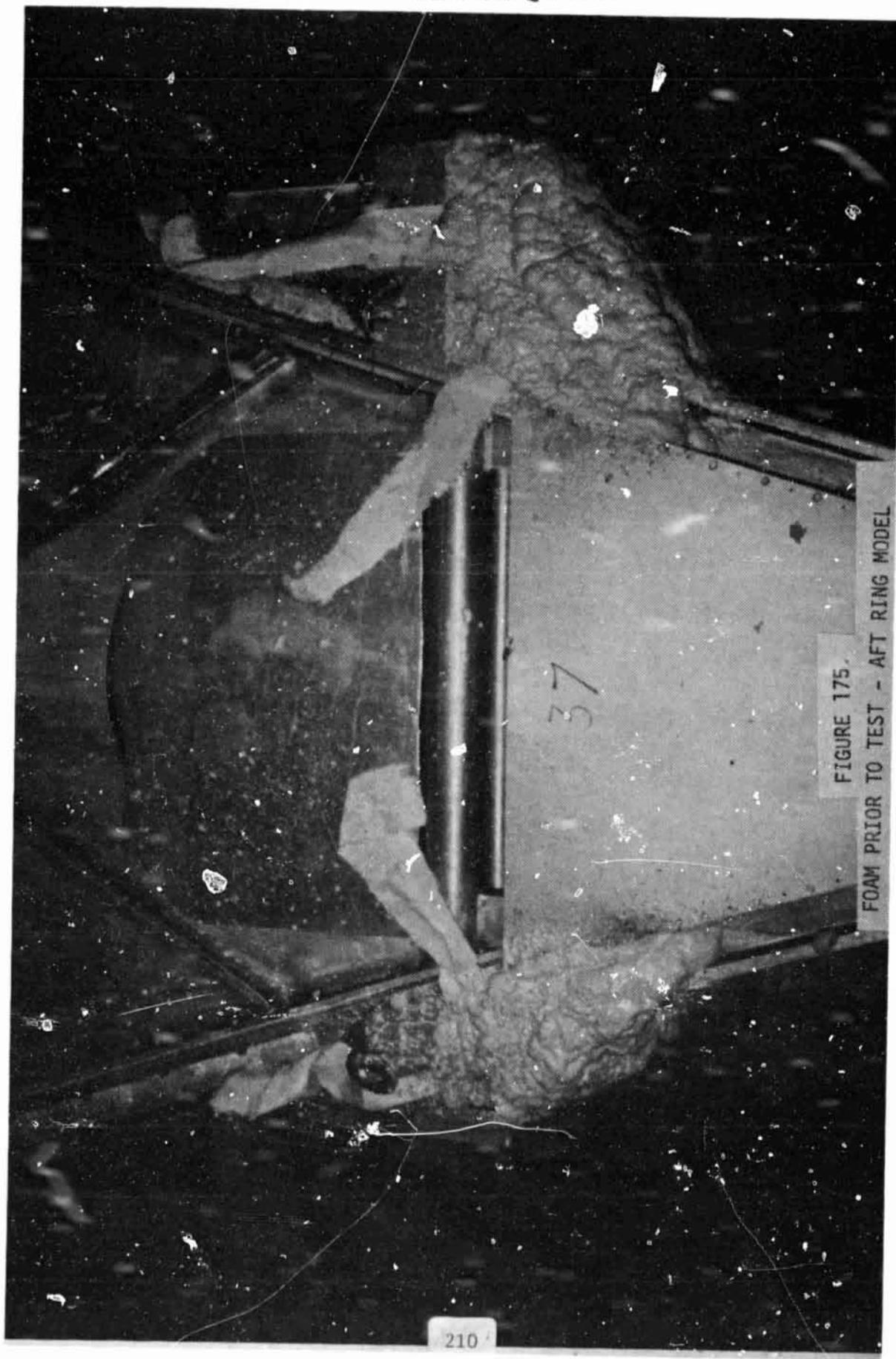


FIGURE 175.
FOAM PRIOR TO TEST - AFT RING MODEL

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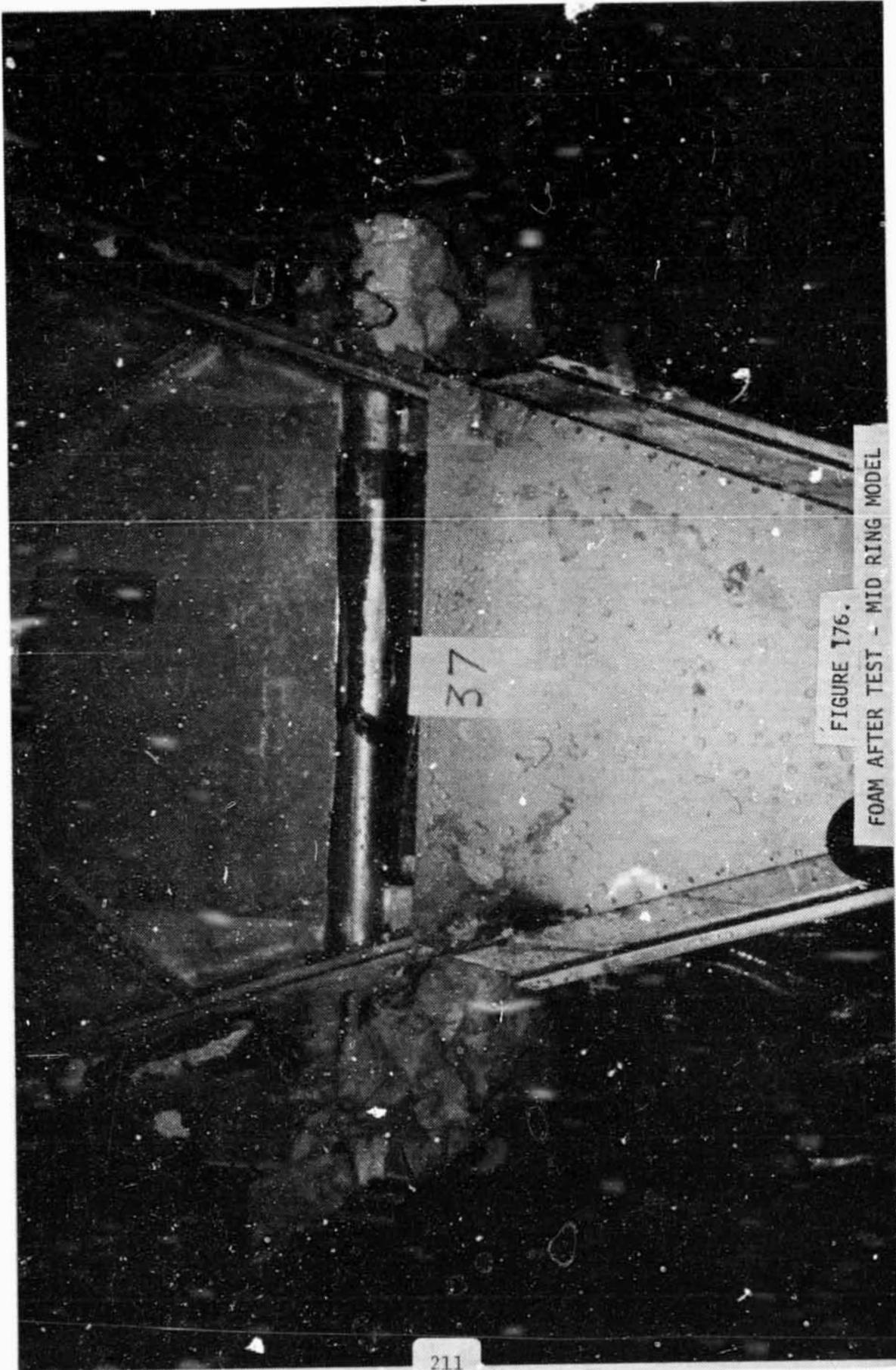


FIGURE 176.
FOAM AFTER TEST - MID RING MODEL

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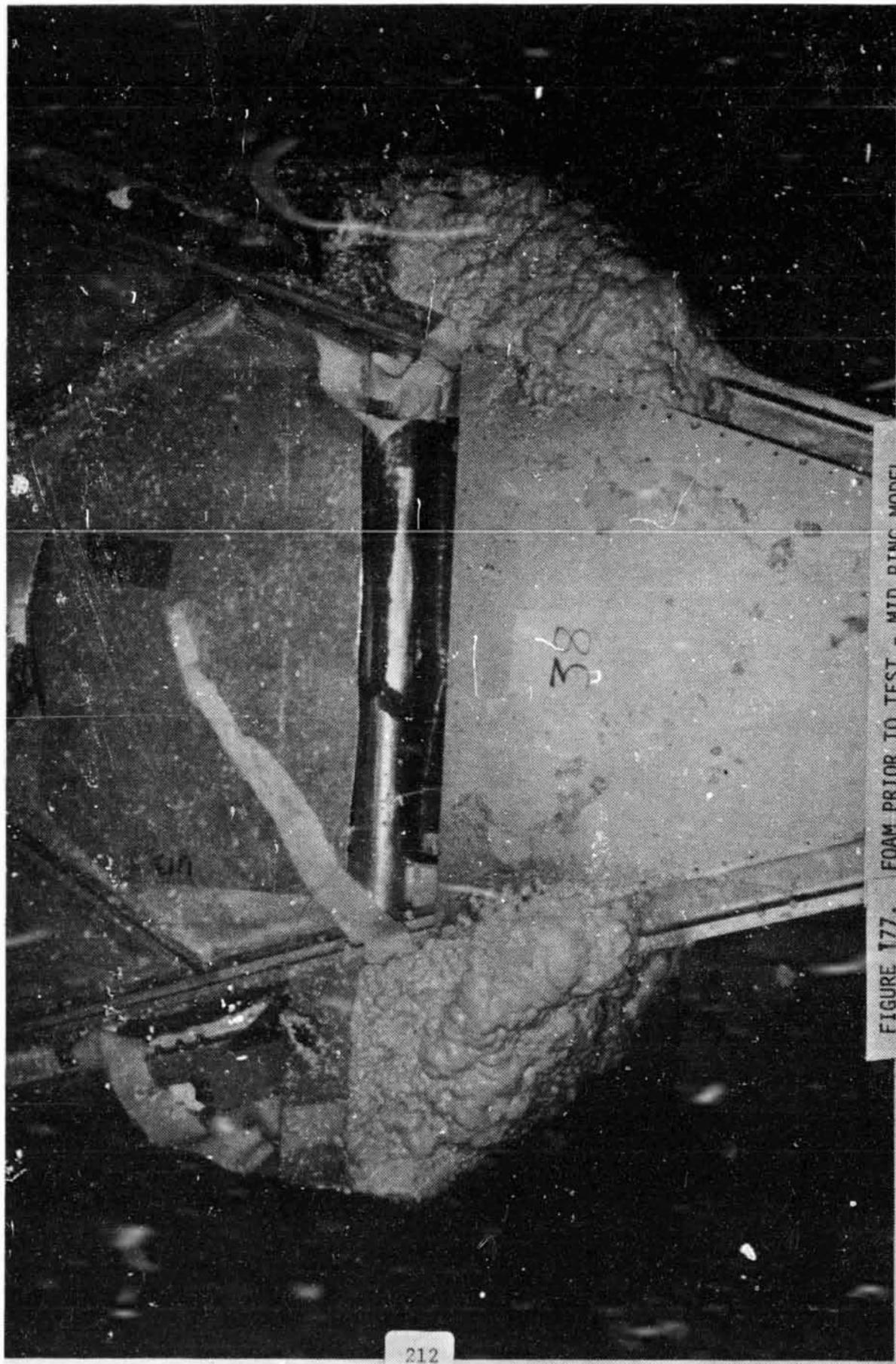


FIGURE 177. FOAM PRIOR TO TEST - MID RING MODEL

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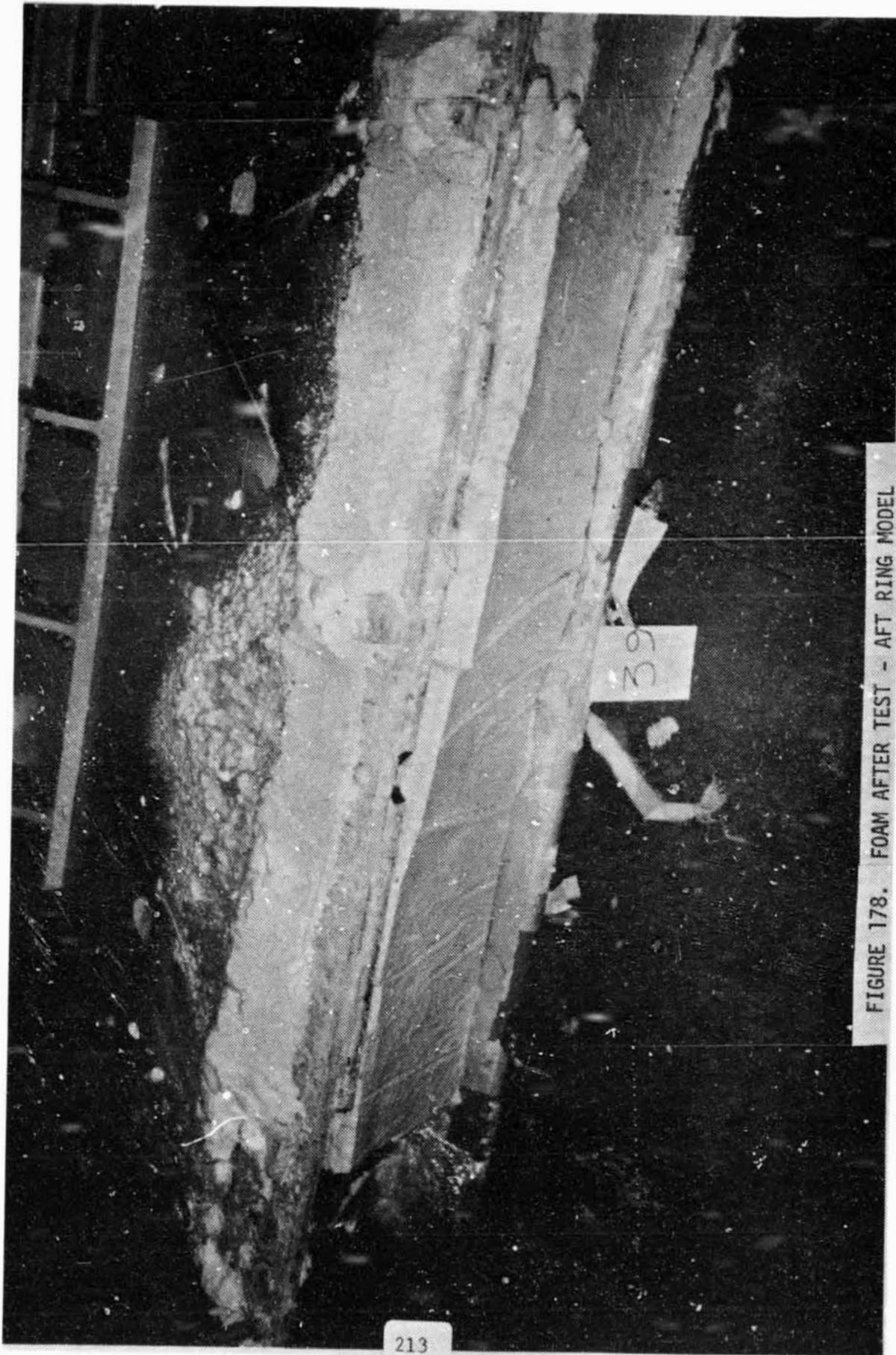


FIGURE 178. FOAM AFTER TEST - AFT RING MODEL

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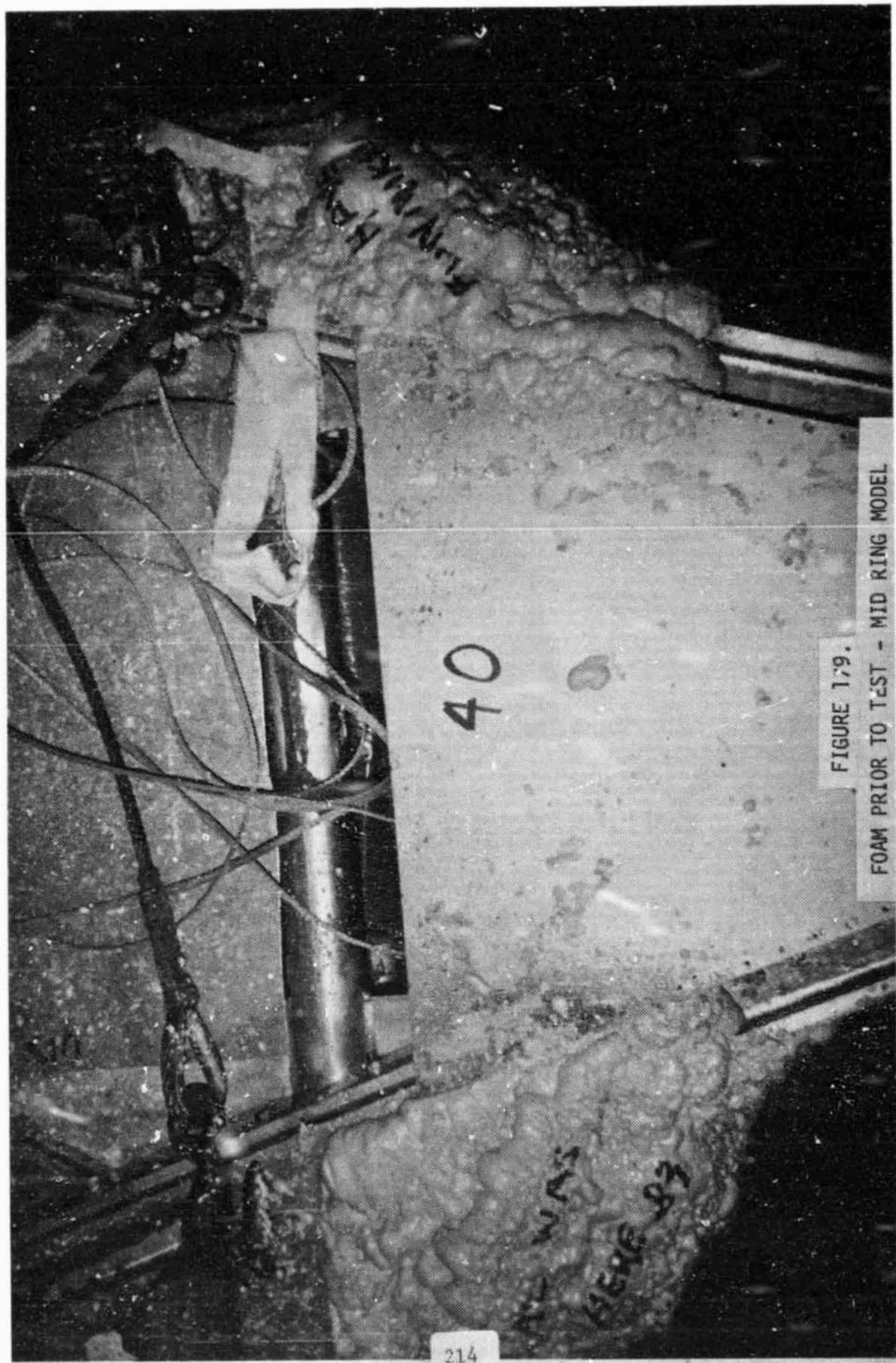


FIGURE 179.
FOAM PRIOR TO TEST - MID RING MODEL

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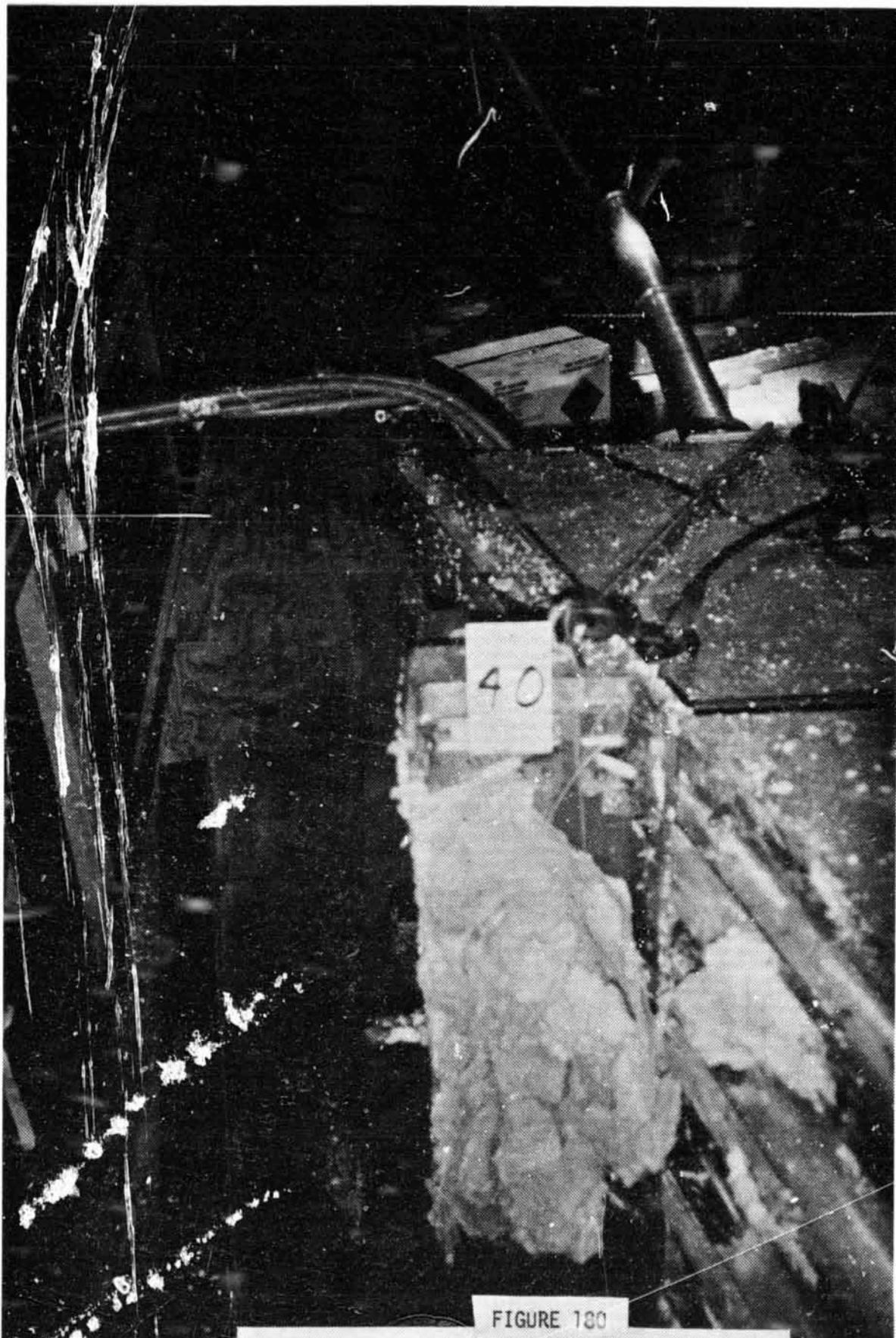
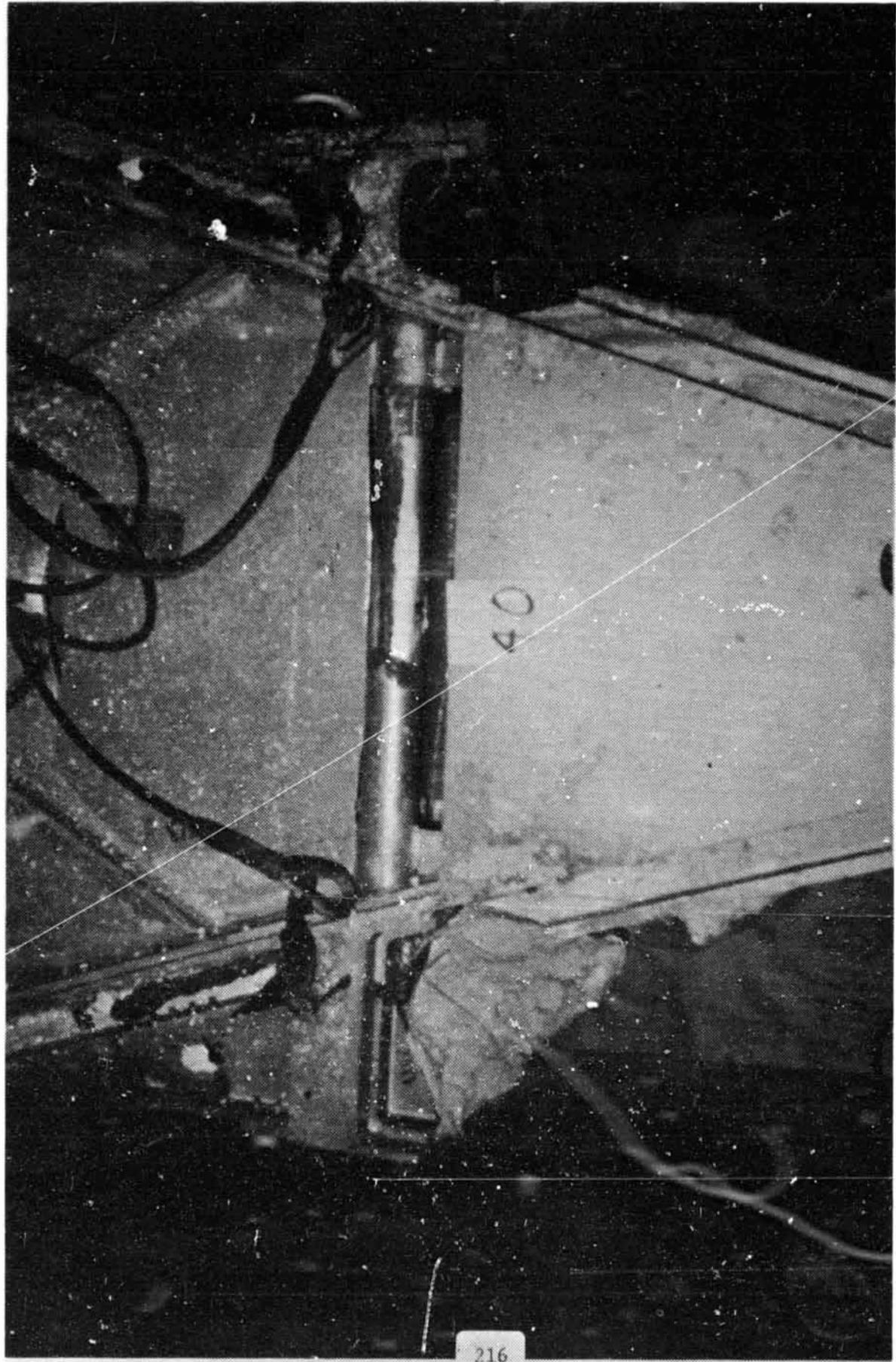


FIGURE 180

FOAM AFTER TEST - FLIGHT RING/MID RING MODEL

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FIGURE 182.
FOAM PRIOR TO TEST - AFT RING MODEL

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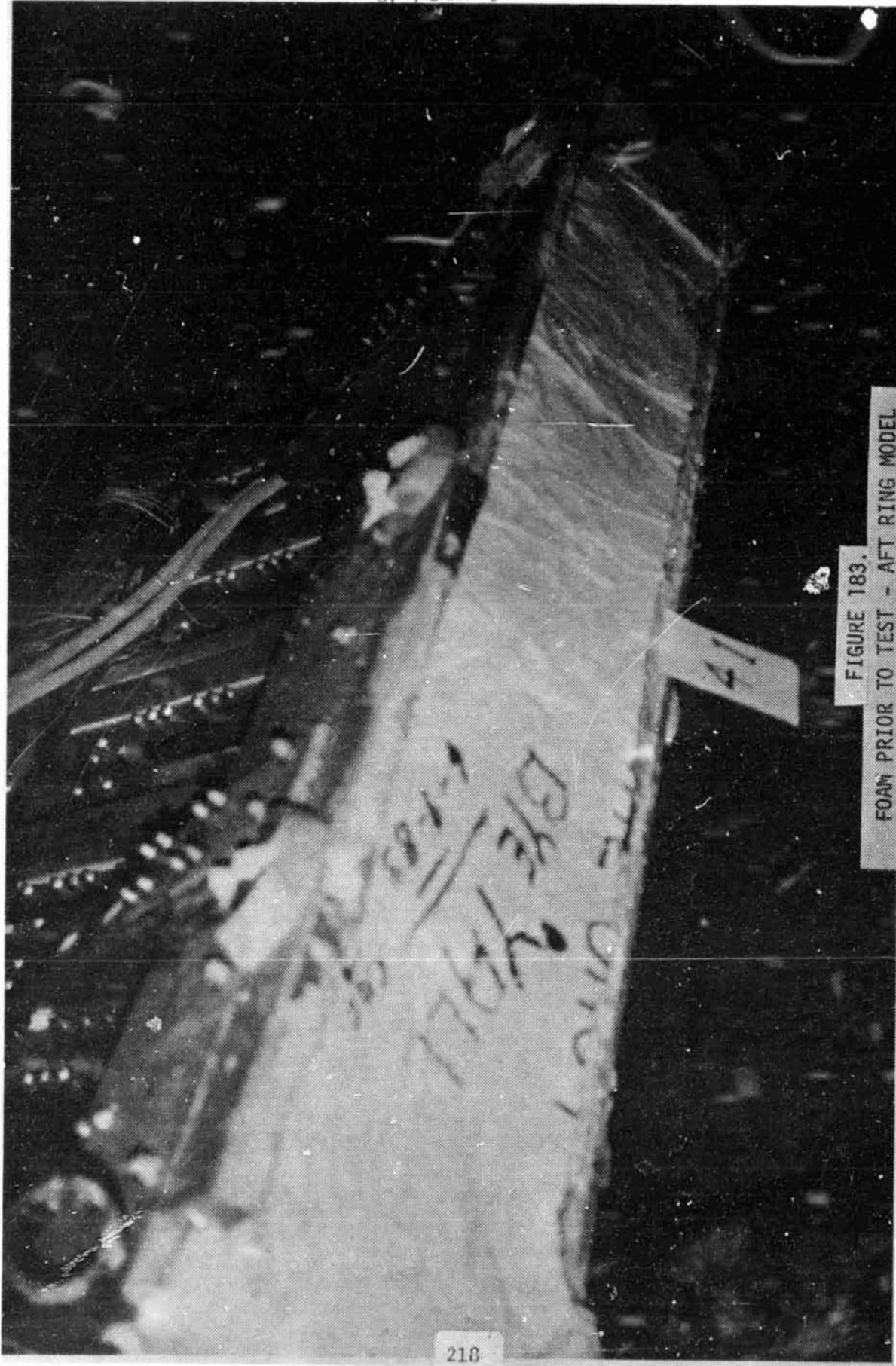


FIGURE 183.
FOAM PRIOR TO TEST - AFT RING MODEL

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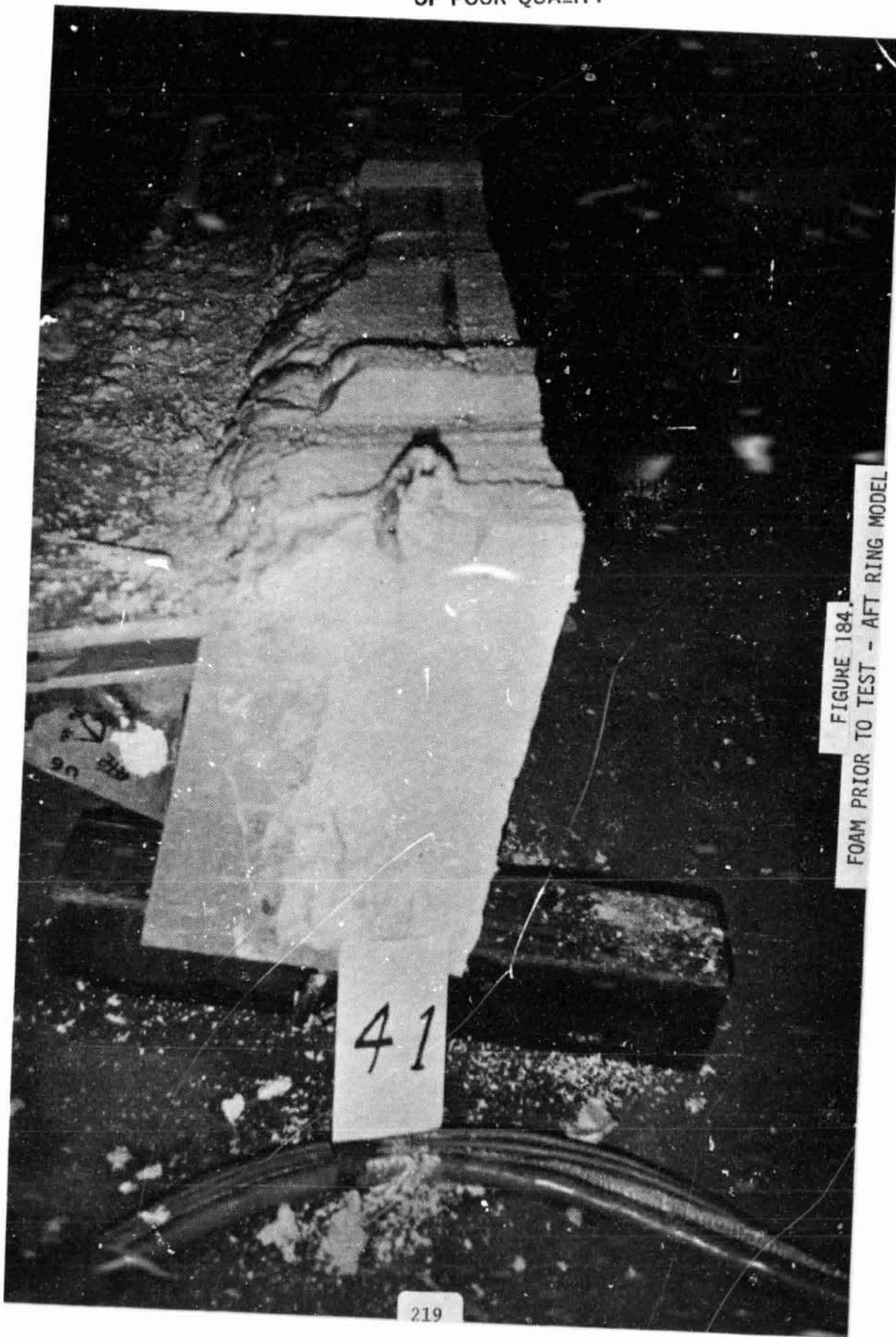


FIGURE 184.
FOAM PRIOR TO TEST - AFT RING MODEL

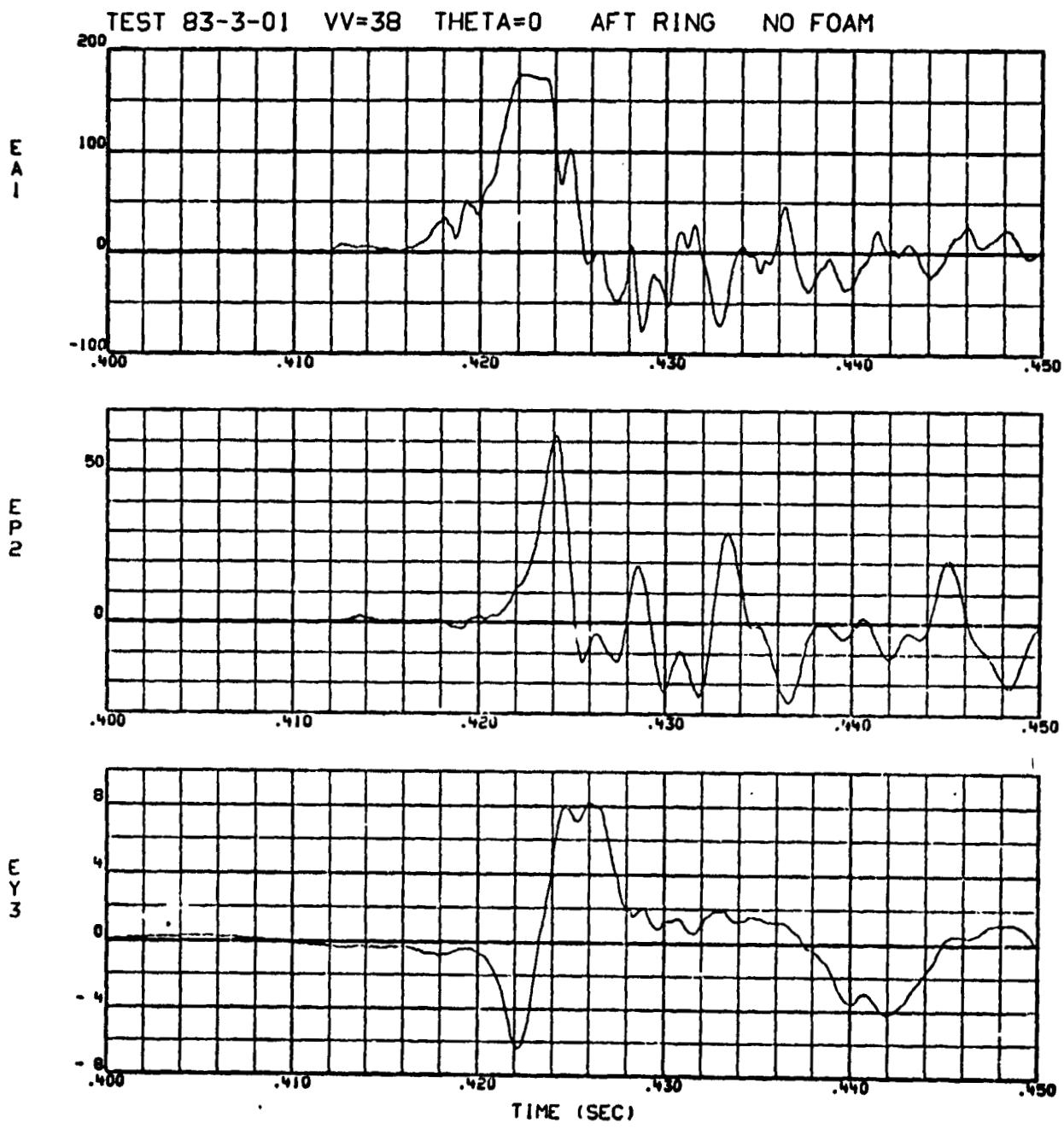
SECTION VIII - TRANSDUCER DATA REDUCTION

The first phase of data reduction was accomplished at the MSFC computation laboratory. The data were filtered with 5000 HZ low pass filters, digitized at 10,000 samples per second and converted to engineering units. Digital tapes containing the data from each test drop were forwarded to the Slidell Computer Center for further processing and plotting.

Transducer data in this report are presented in numerical order, 3 plots per page, for each test drop. Time zero on the plots differs for each run. Approximately 50 milliseconds of data at 10,000 samples per second are presented for each measurement. Each time slice is chosen to illustrate the largest magnitude load event. All transducers are biased to a zero average over a time interval chosen to represent free fall, normally 10 milliseconds beginning approximately 20 milliseconds before initial water contact. Units on the plots are g's for accelerations, psig for pressures, and micrometers/meter for strain gage data.

Sample data plots are presented in Figures 185 through 198. Data plots for all test runs are presented as the Appendix. Volumes 1 and 2 of the Appendix contain all data for the Aft Ring Model while Volumes 3 and 4 contain all data for the Mid Ring Model.

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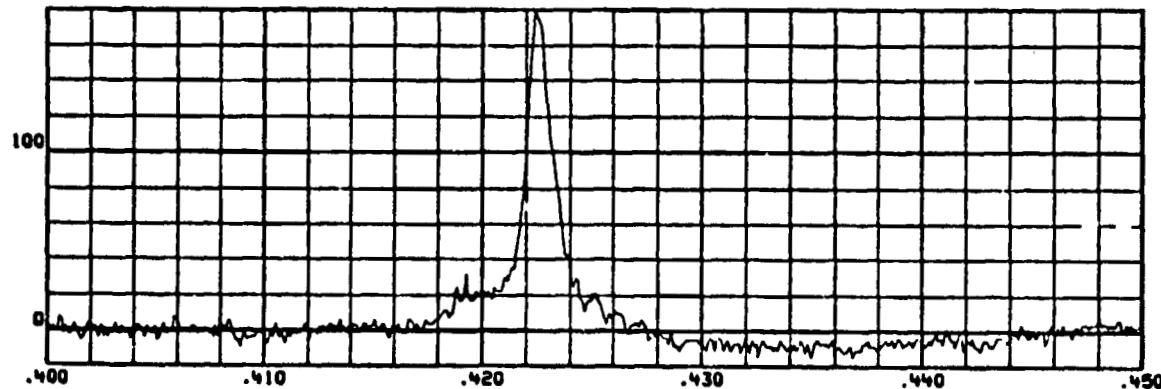
PAGE 1

FIGURE 185. SAMPLE DATA

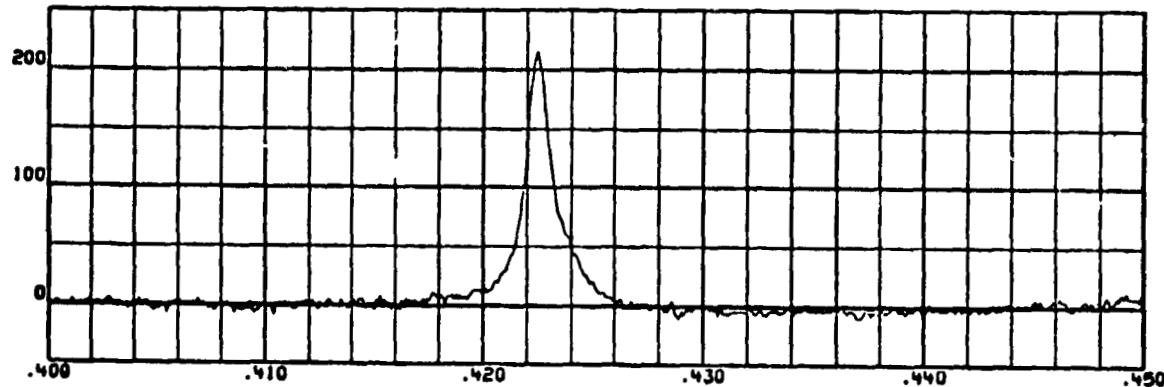
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TEST 83-3-01 VV=38 THETA=0 AFT RING NO FOAM

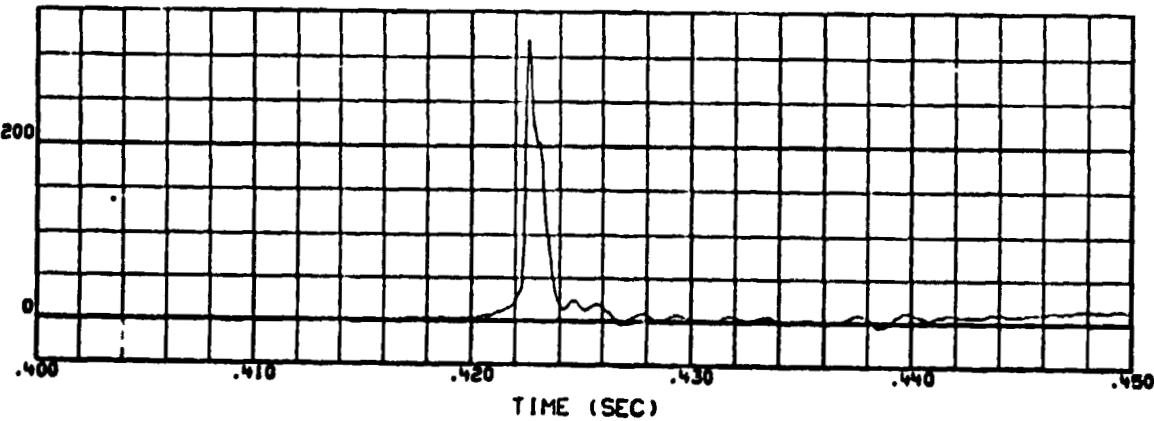
A 0 1



A 0 2



A 0 3

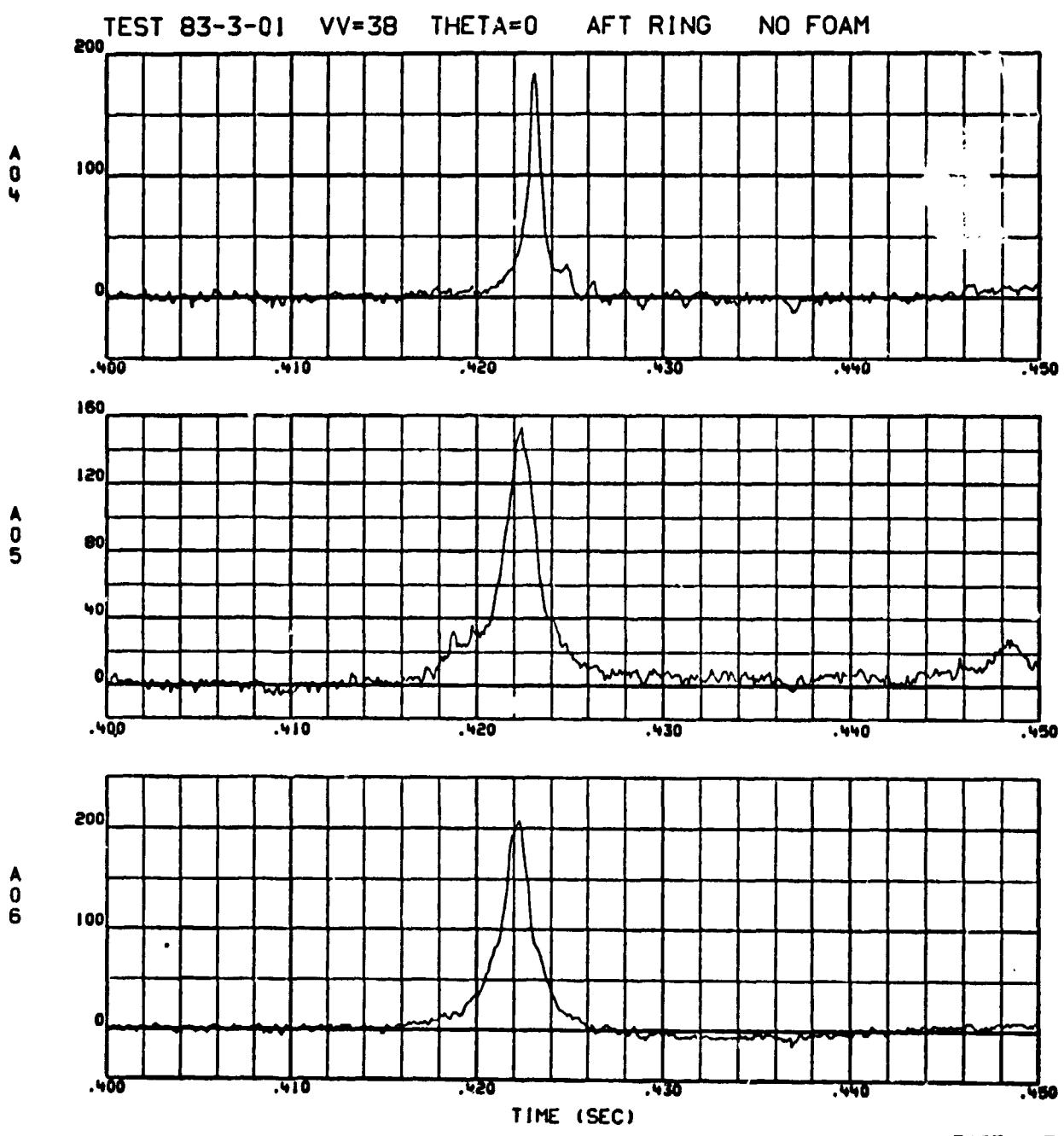


TIME (SEC)

PAGE 2

FIGURE 186. SAMPLE DATA

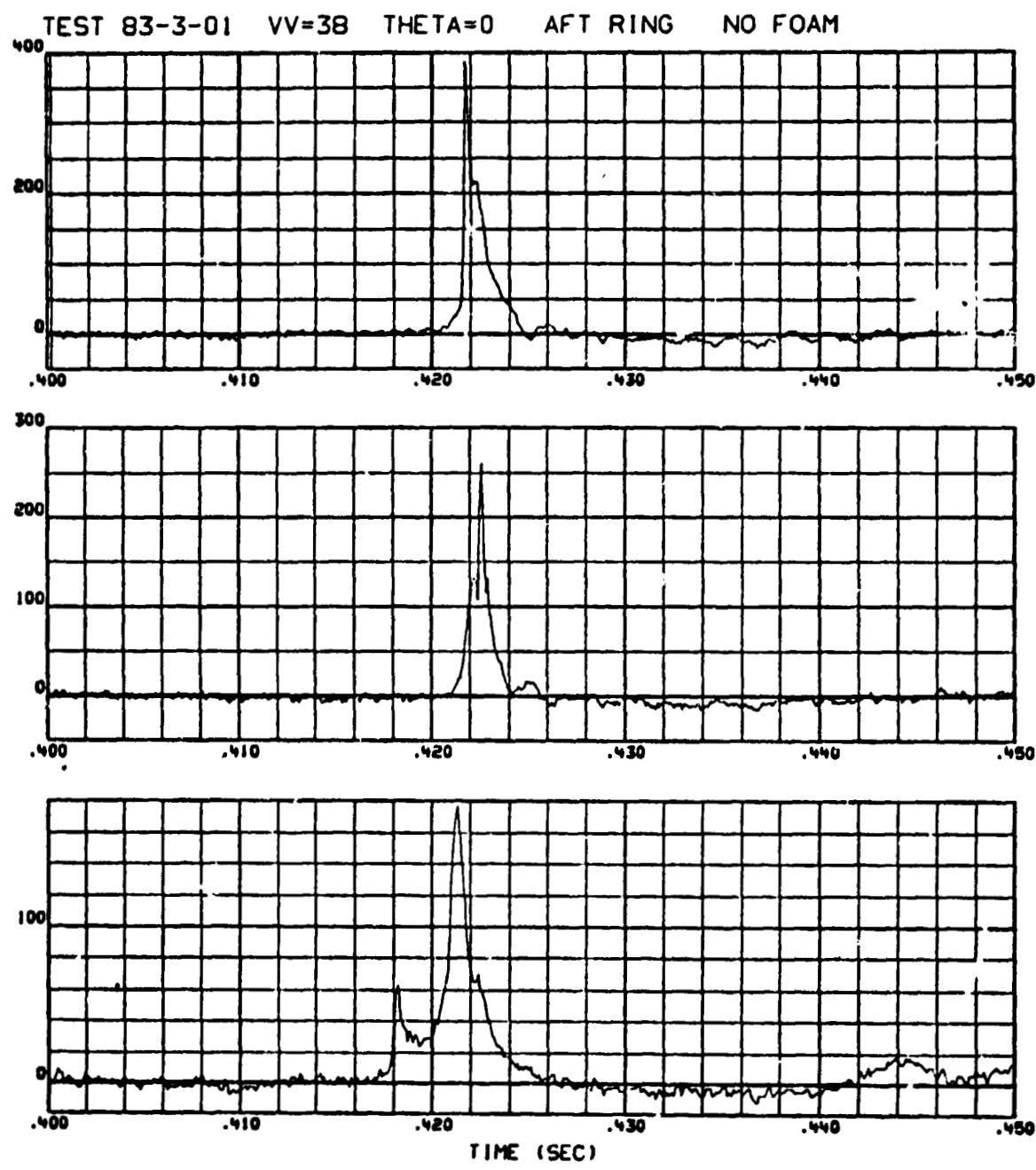
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PAGE 3

FIGURE 187. SAMPLE DATA

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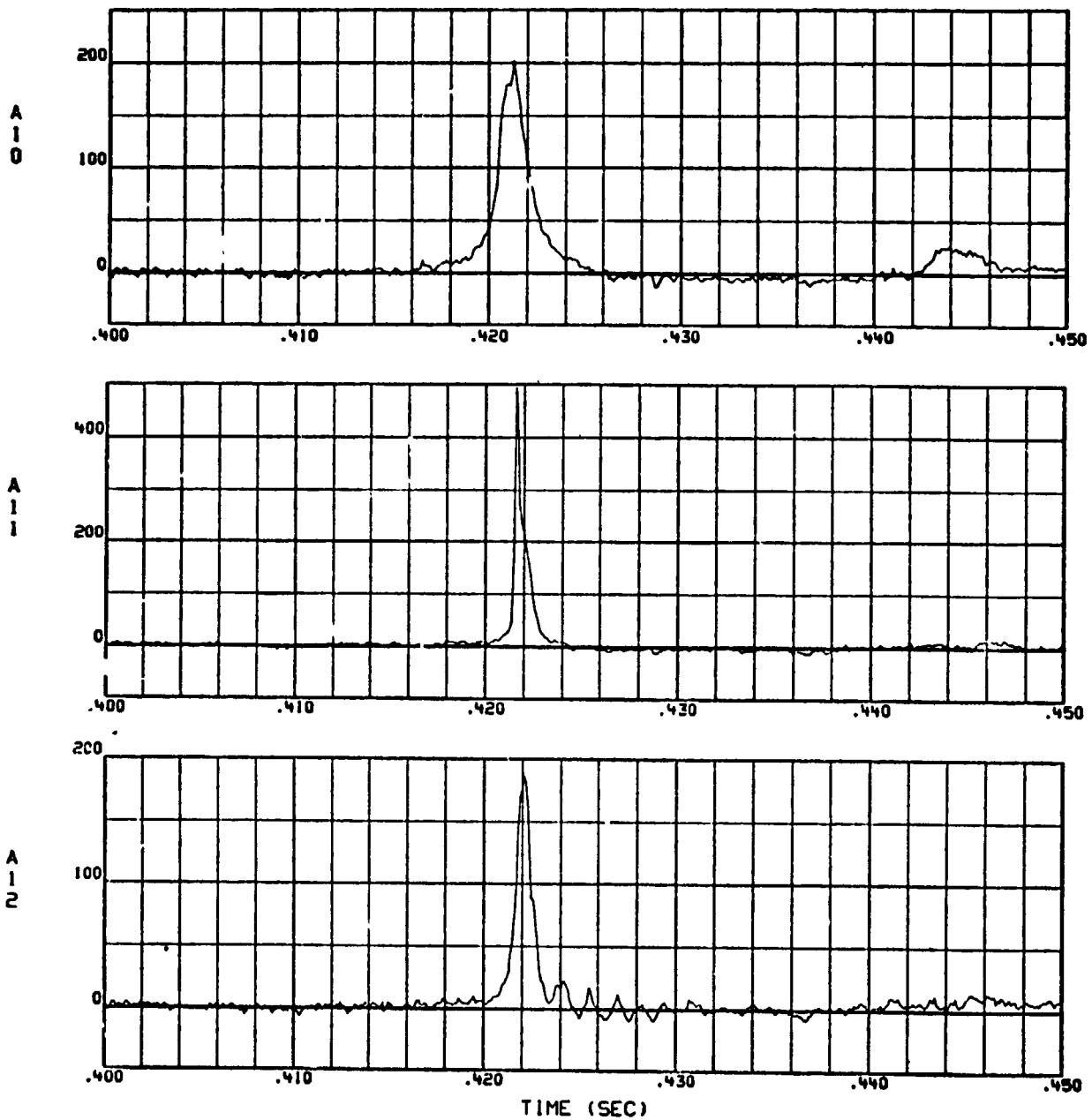


PAGE 4

FIGURE 188. SAMPLE DATA

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TEST 83-3-01 VV=38 THETA=0 AFT RING NO FOAM



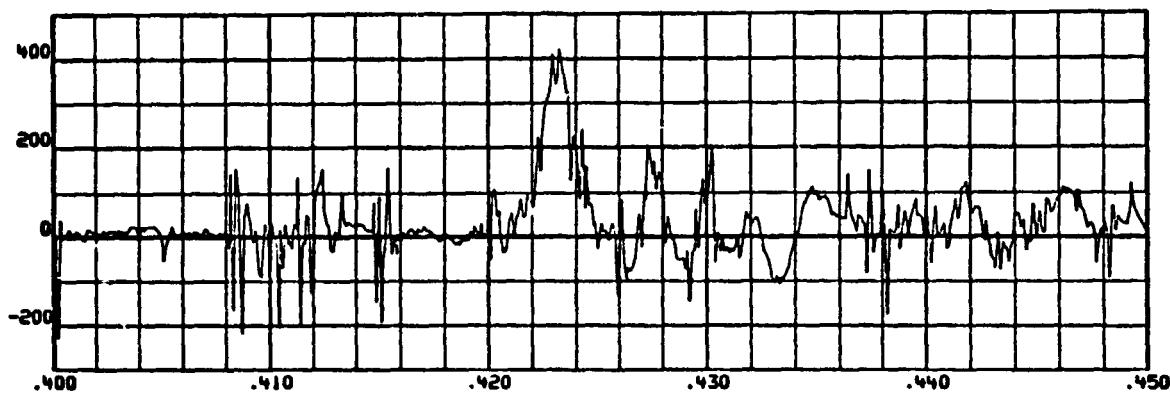
PAGE 5

FIGURE 189. SAMPLE DATA

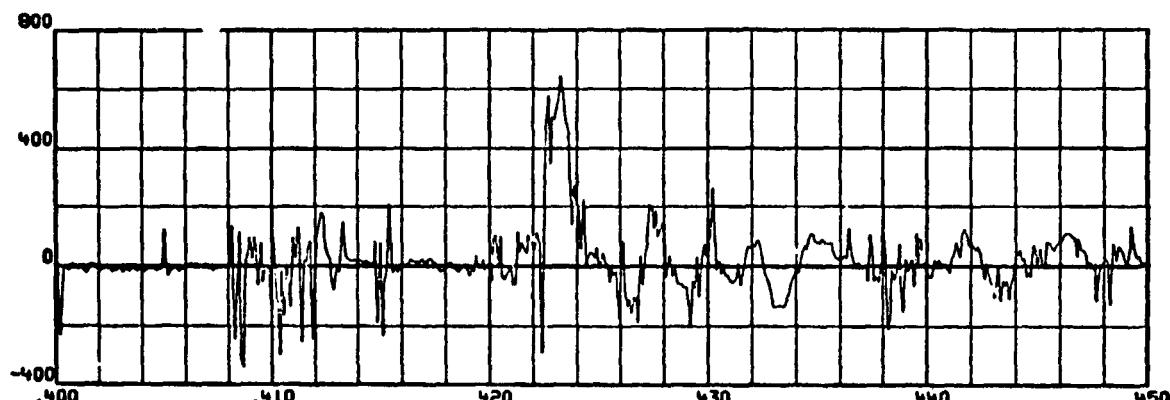
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TEST 83-3-01 VV=38 THETA=0 AFT RING NO FOAM

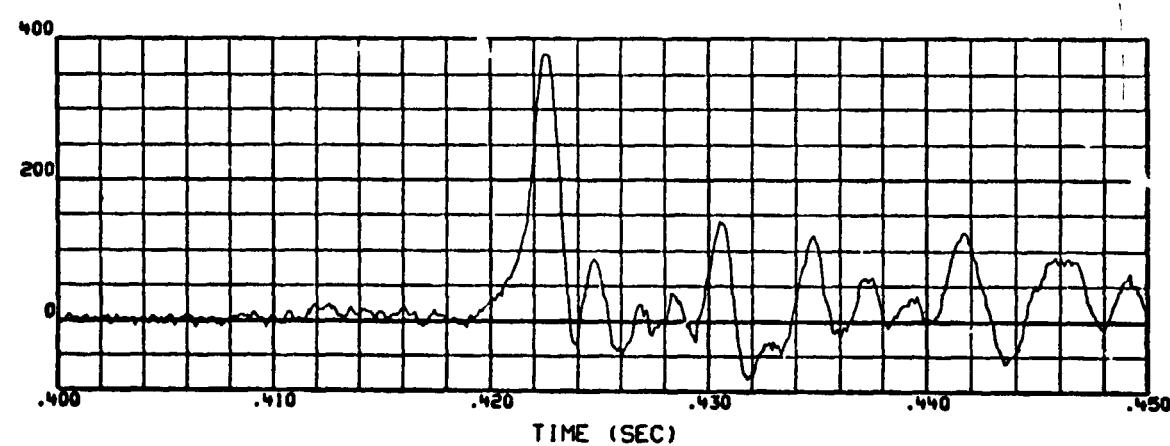
U₁



U₂



U₃

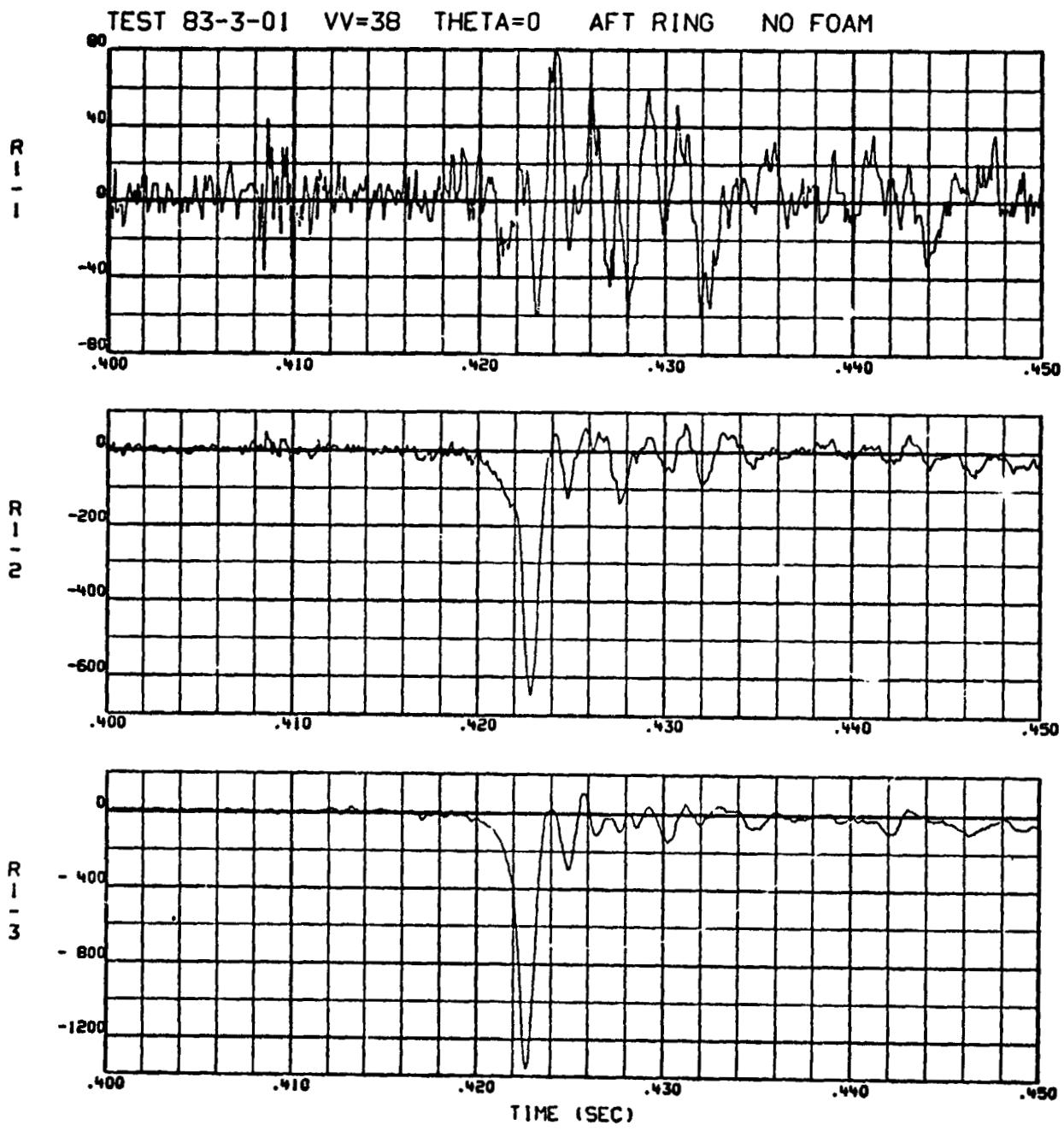


TIME (SEC)

PAGE 6

FIGURE 190. SAMPLE DATA

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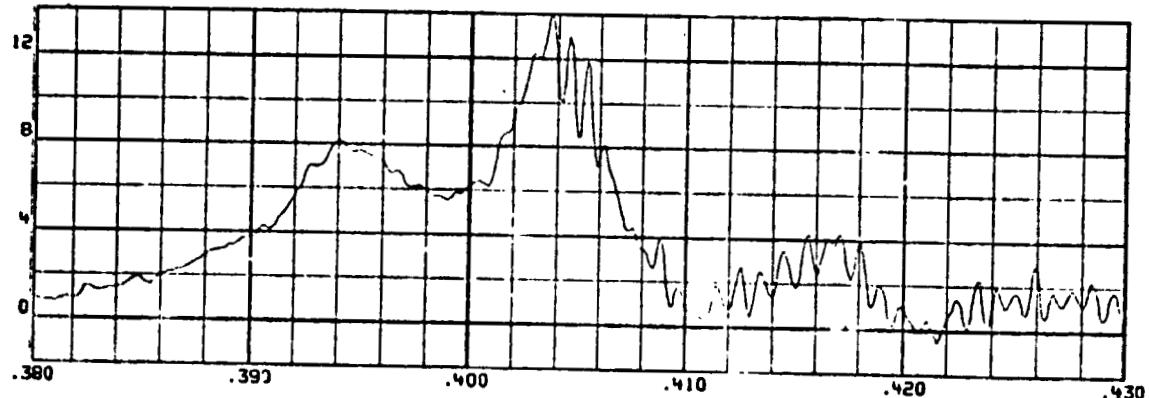
PAGE 15

FIGURE 191. SAMPLE DATA

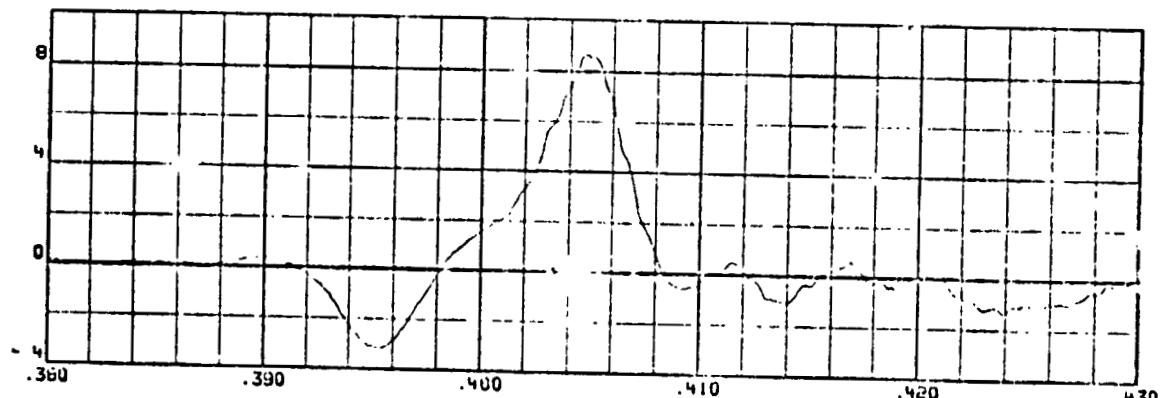
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TEST 83-3-10 VV=22 THETA=0 MID RING NO FOAM

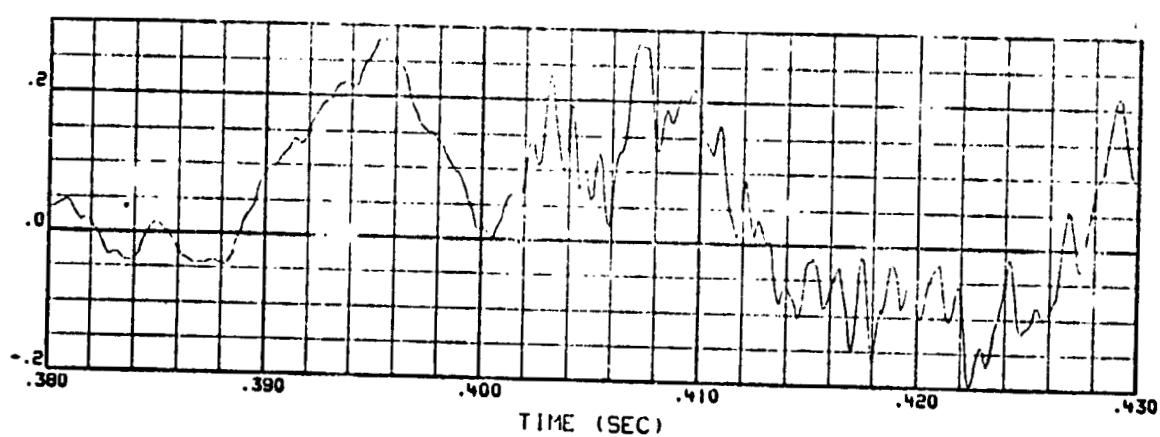
E A 1



E P 2



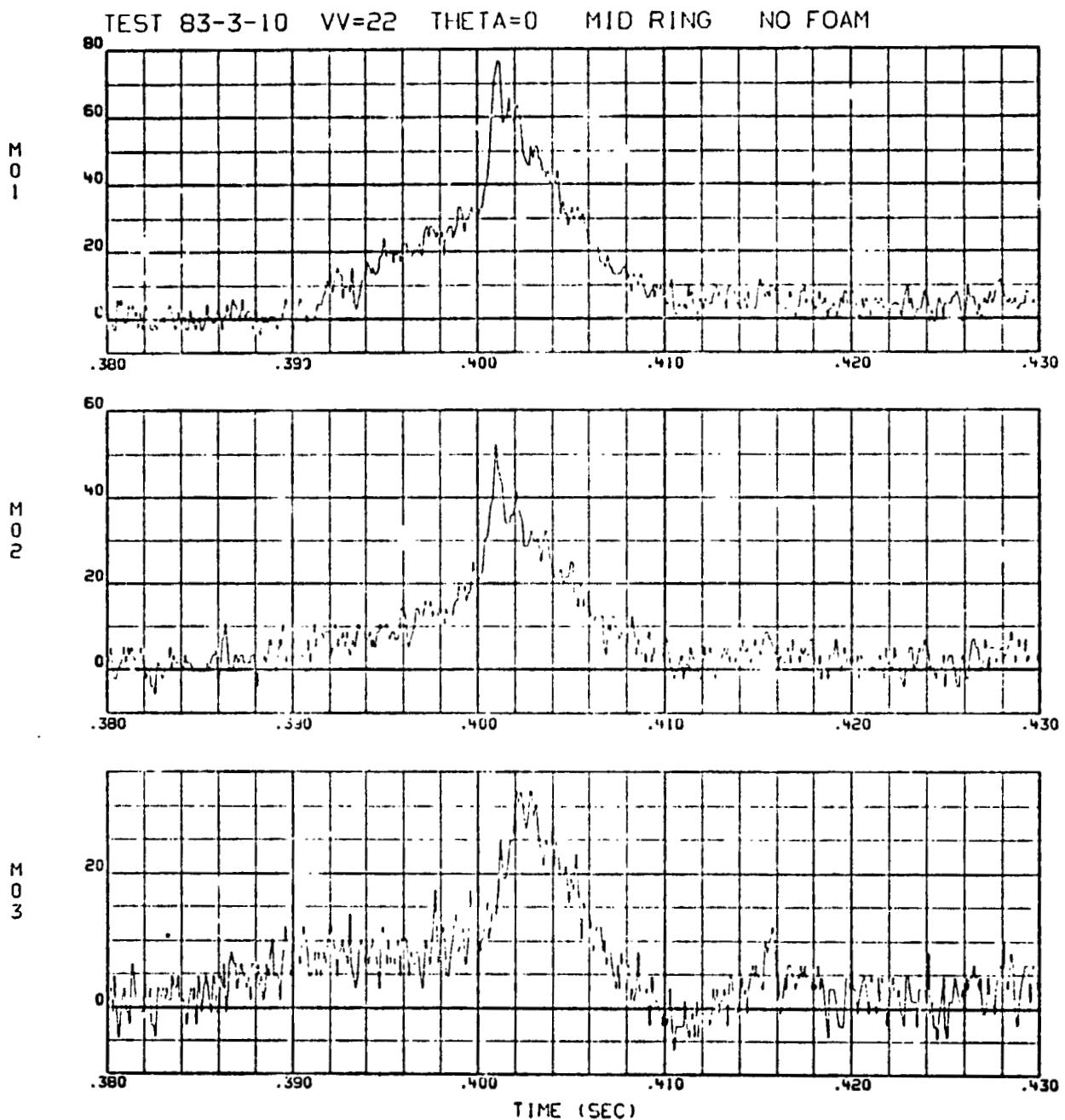
E Y 3



PAGE 1135

FIGURE 192. SAMPLE DATA

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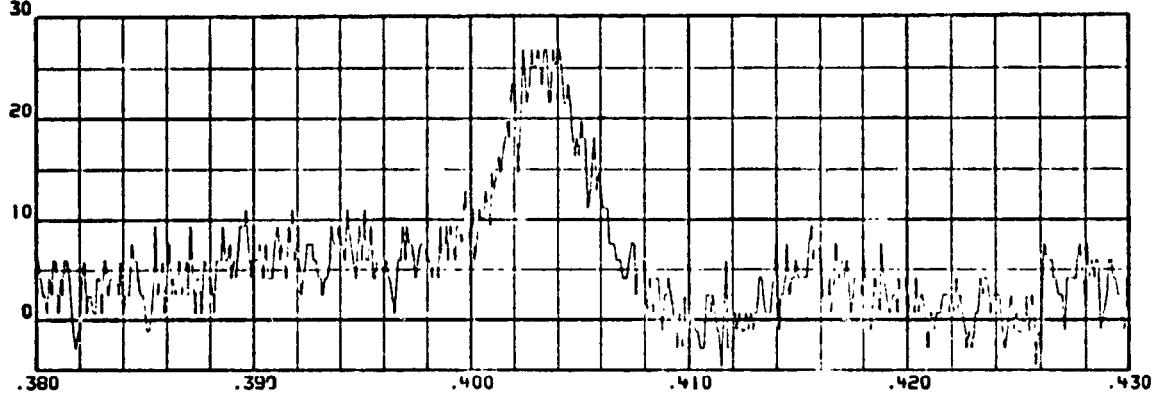
PAGE 1136

FIGURE 193. SAMPLE DATA

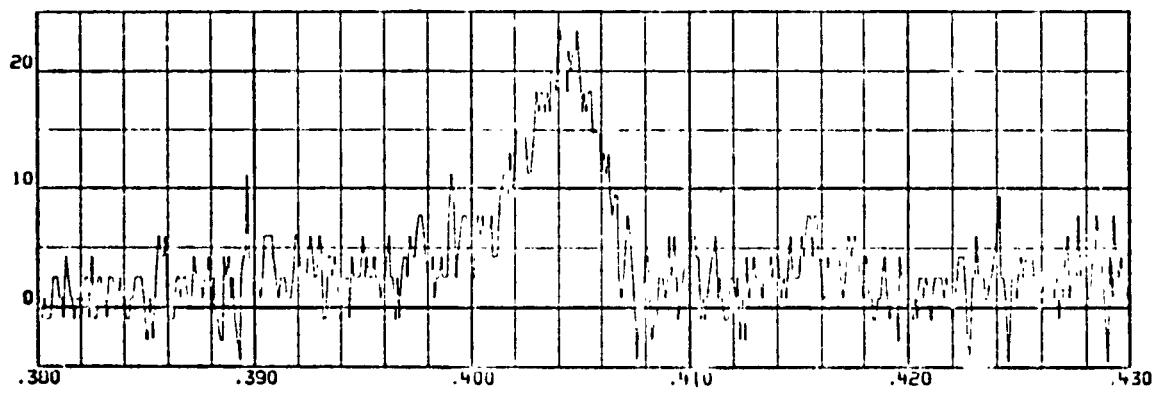
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TEST 83-3-10 VV=22 THETA=0 MID RING NO FOAM

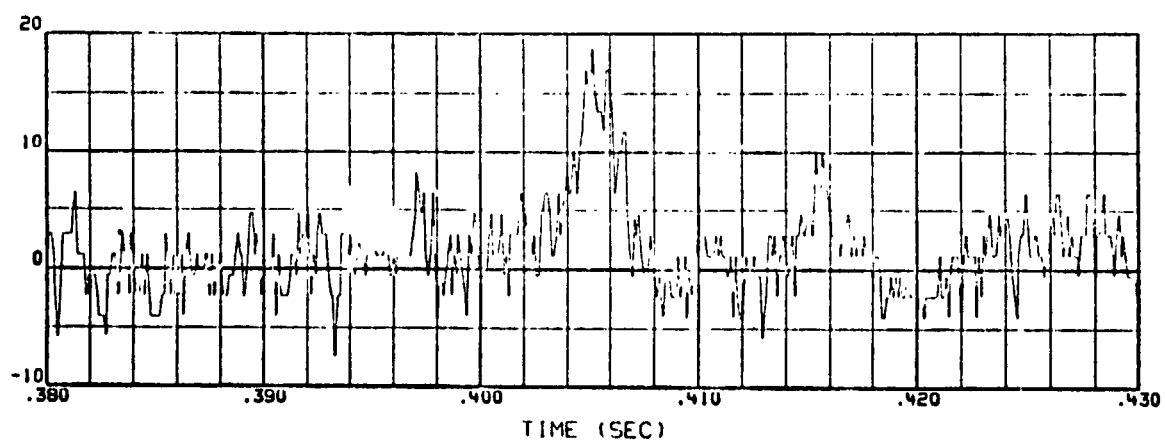
M 0 4



M 0 5



M 0 6



TIME (SEC)

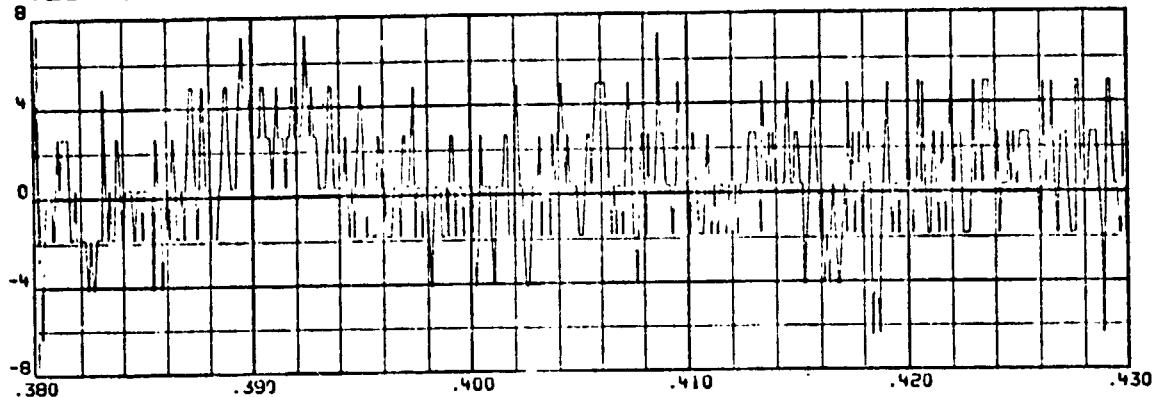
PAGE 1137

FIGURE 194. SAMPLE DATA

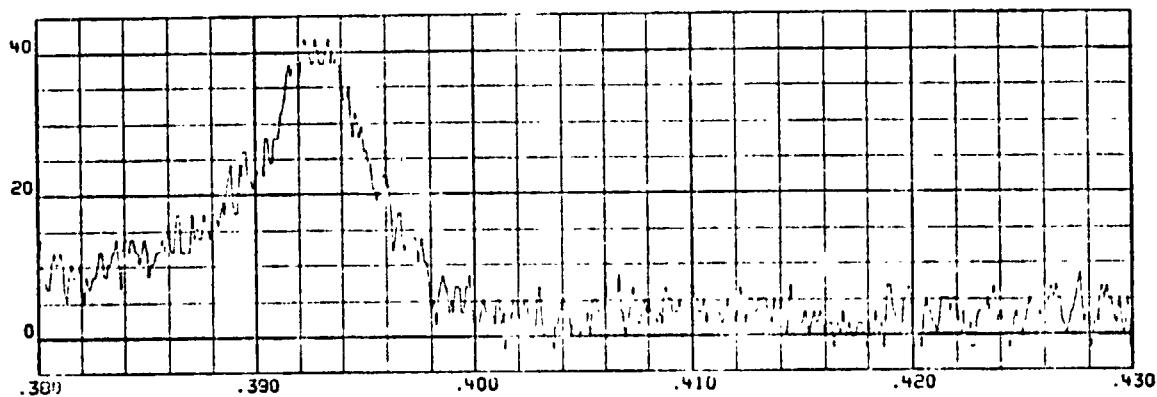
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TEST 83-3-10 VV=22 THETA=0 MID RING NO FOAM

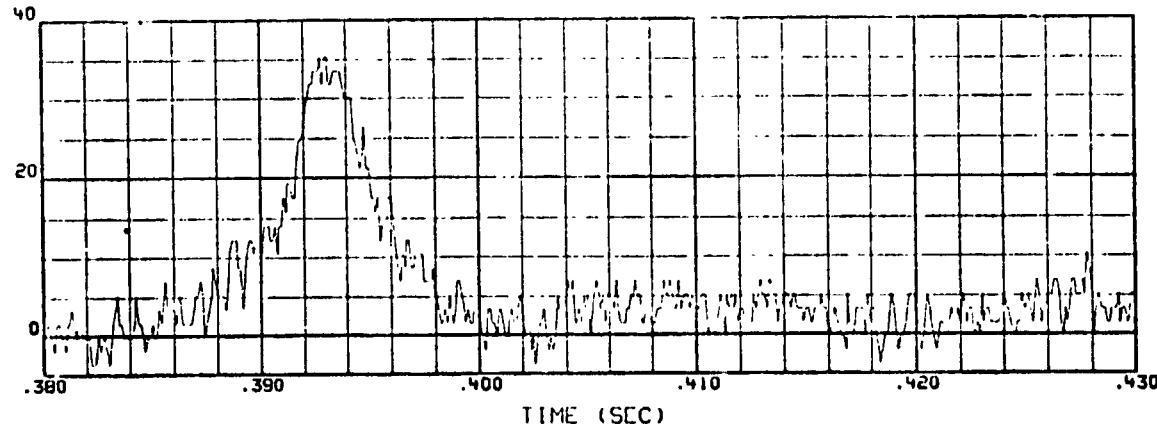
M 07



M 08



M 09



TIME (SEC)

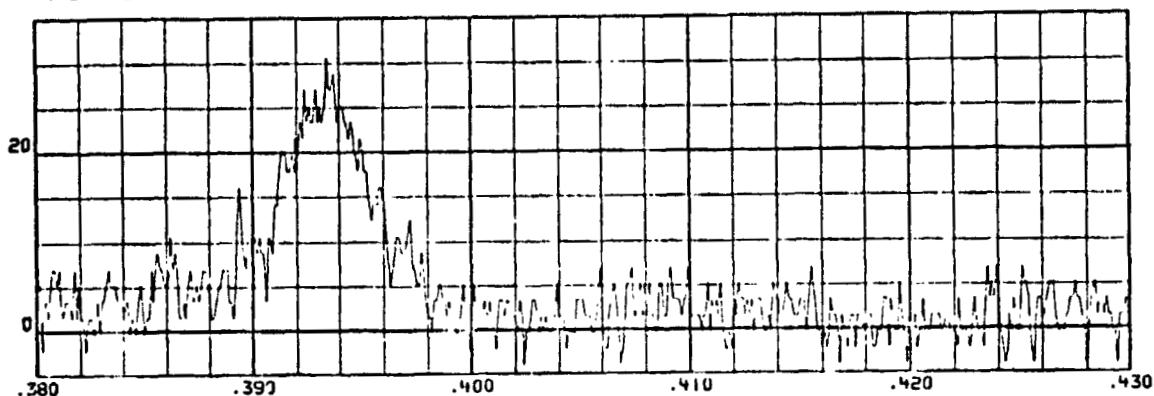
PAGE 1138

FIGURE 195. SAMPLE DATA

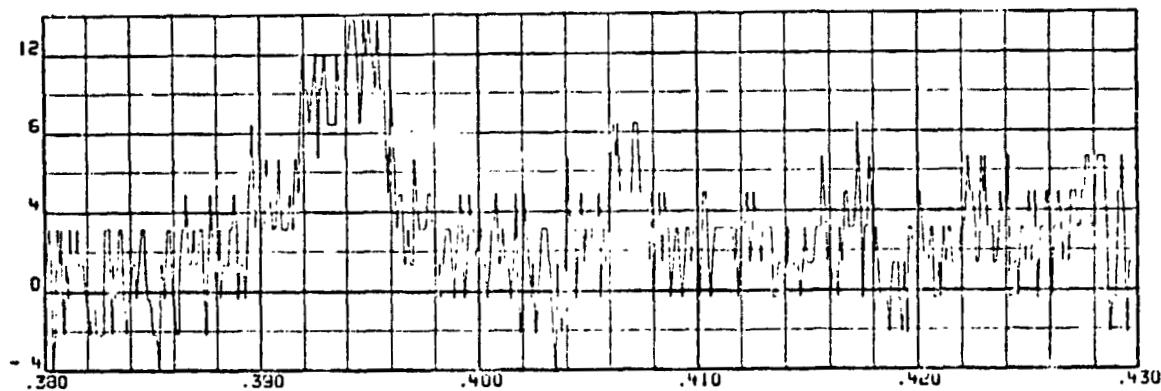
ORIGINAL PAGE IS
OF POOR QUALITY

TEST 83-3-10 VV=22 THETA=0 MID RING NO FOAM

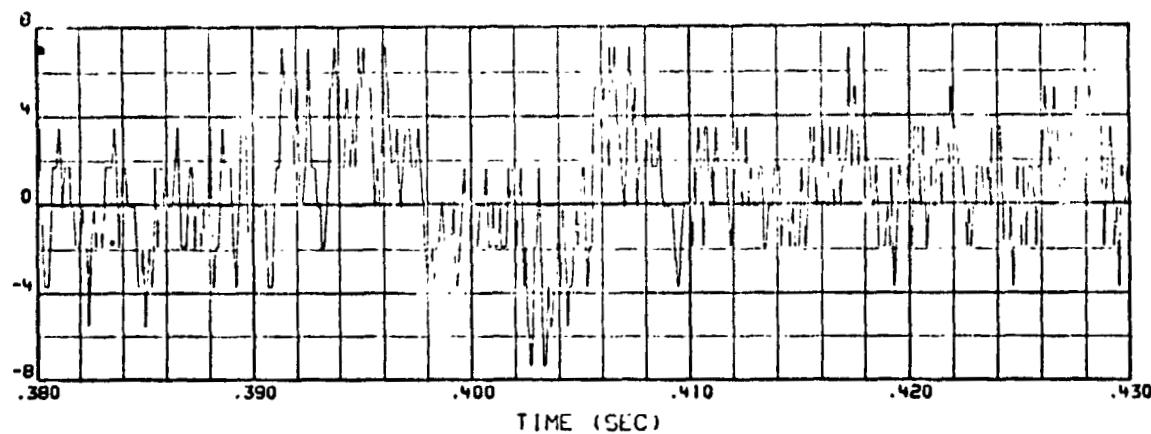
M₁₀



M₁₁



M₁₂

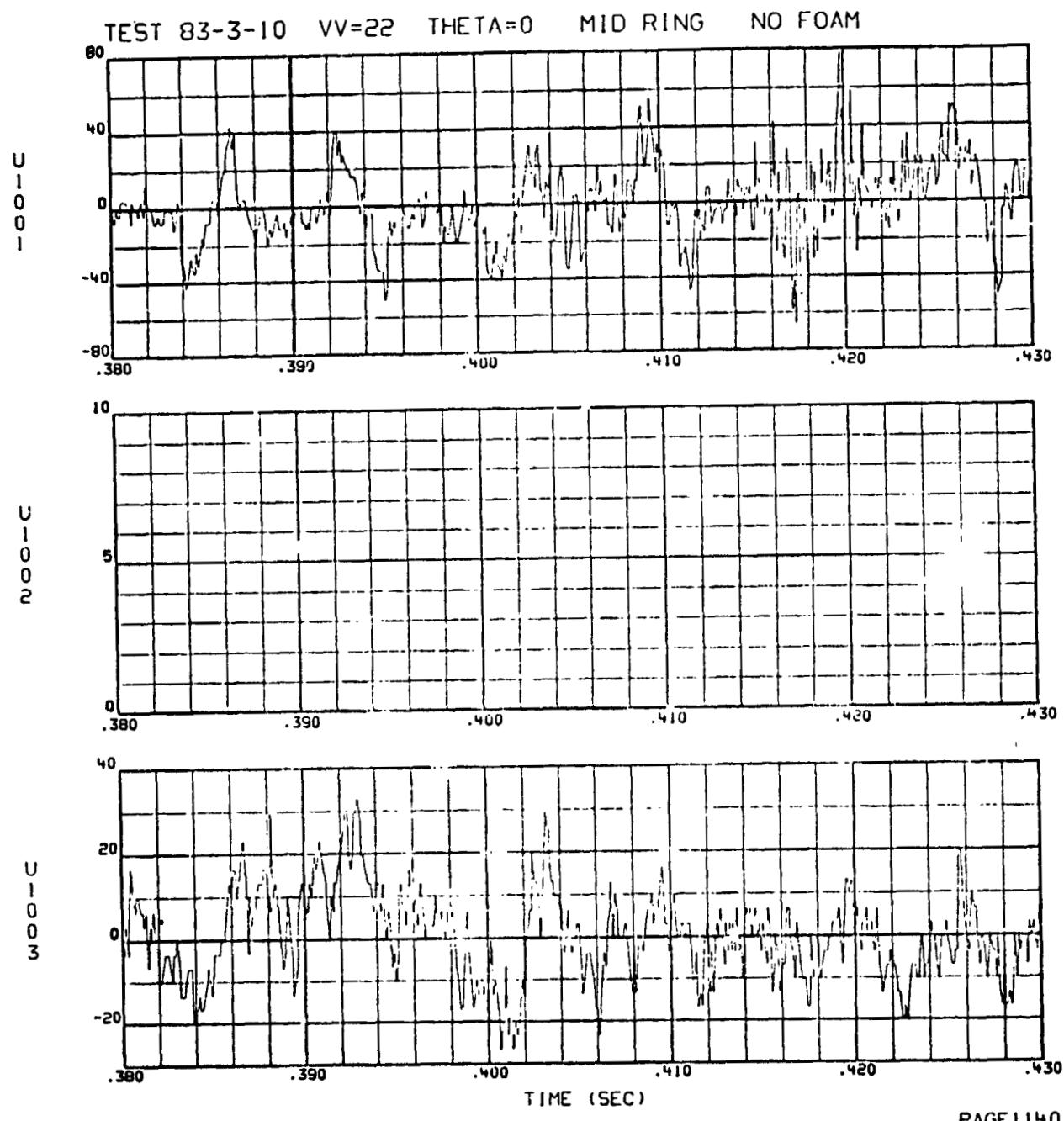


TIME (SEC)

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FIGURE 196. SAMPLE DATA

ORIGINAL PAGE IS
OF POOR QUALITY



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FIGURE 197. SAMPLE DATA

ORIGINAL PAGE IS
OF POOR QUALITY

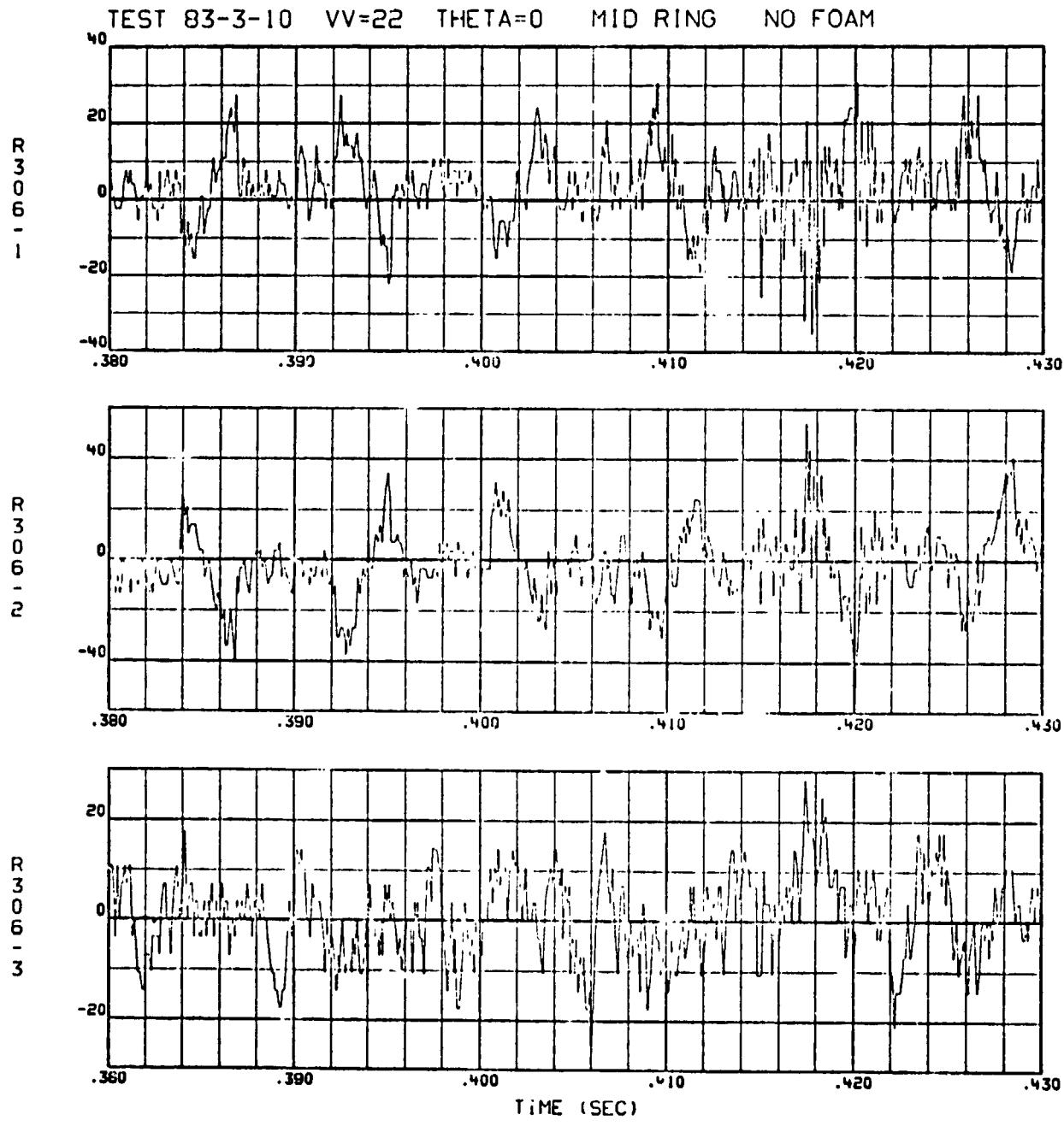


FIGURE 198. SAMPLE DATA

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